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HERBERTIA

International Journal of the American Plant Life Society, devoted to the increase and diffusion of knowledge on bulbous plants and petaloid monocot families, especially the Amaryllidaceae.

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IN THIS ISSUE...

This second and final number of Volume 43 contains articles from several new contributors. Sr. Castillo continues his article on the beautiful and often endangered bulbous plants of his homeland in Argentina and environs. Botanists working in the floristic relationships of Greece and Turkey provide overviews of bulbous plants from those areas. Dr. Meerow has provided a review of a poorly known, yet incredibly beautiful group of South American amaryllids. Dr. Lehmillier has three articles in this issue, each dealing with a different aspect of his interest in Crinums. The compilation of current literature rounds off this final, albeit a bit late, issue for 1987.

R. Mitchel Beauchamp, Editor

Cover: *Herbertia amatorium*, from a color slide by Stan Farwig.

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HERBERTIA
Volume 43, Number 2, 1987

TABLE OF CONTENTS

Notes on the Cultivation of South American Bulbous Plants (II) Jose A. Castillo	2
Some Autumn-Flowering Bulbs of Greece Arne Strid	12
Observations of Crinum americanum L.; The Neches River Revisited David J. Lehmiller	22
Notes on Some Fritillaries in Cultivation Kit Tan and R.J.D. McBeath	33
A Review of Stenomesson Alan W. Meerow	42
A South African Crinum Safari David J. Lehmiller	50
Plant Conservation in Natal David J. Lehmiller	60
The Hippeastrum Species: Some Recollections and Observations by an Amateur Grower Douglas D. Craft	63
Recent Literature of Interest to Readers	65
Date of Publication	71

NOTES ON THE CULTIVATION OF SOUTH AMERICAN BULBOUS PLANTS (II)

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IT IS sad that in this second part of these "Notes" I have to refer again to the subject of endangered species. It is imperative that some action be taken on an international scale to preserve stocks of rare South American plants under cultivation. It is important to mention that the subject species are not senile, but are perfectly healthy and strong. They would survive for centuries save for the destruction of their native habitats. Agriculture, cattle raising and development are extirpating their populations. *Rhodophiala bifida* Phil., a well-known plant in the Gulf States and once growing in countless millions in the Buenos Aires area and elsewhere in the provinces of Entre Ríos and Buenos Aires and in Uruguay, is now rare and seldom seen. This is but one example of just another species, and one very interesting to horticulture that may disappear lest we reproduce and distribute it as widely as possible. We also ignore the issue of what is the minimum number of interbreeding clones necessary to keep the species going. Besides, one can not collect all the plants in a given area because cultivation methods are not certain. On the other hand those left undisturbed may not be found later on. It is safe to say that all species inhabiting land suitable for agriculture in South America are threatened with extinction. So your own experience with these plants may be of help and very important for their survival. The examples of *Moraea aristata* (Delaroche)Asch. & Graebn. and *Gladiolus caryophyllaceus* (Burman f.)Poiret, almost gone forever in their native South Africa and currently spreading almost in weed fashion in Australia are perhaps showing us that outstanding results can also be obtained from cultivating certain species outside their native habitats where the presence of predators (insects, fungi and bacteria) would be a drawback. Not that one would advocate the unrestricted introduction of alien plants. This would have tragic consequences as experience has shown by past indiscretions. *Homeria* species in Australia, *Arum italicum* Mill. and *Iris pseudacorus* L. in Argentina are among the many undesirable subjects that once introduced have run rapidly out of control. Here *Hesperoxiphion peruvianum* Bak. flowers in its second season from seed and in Southern California *Alophia drummondii* (Grah.)R.C. Foster flowers in one season, just like any other annual. Many exciting horticultural discoveries await the interested grower.

The absence of pollinators may render the whole horticultural experience a failure. Many South American bulbs depend on beetles for their pollination and the flowers' scent is not precisely pleasant, so bees may not be of help. In many cases species are self incompatible, so more than one clone should be under cultivation; something not easy when rare species are involved. In many cases, a substantial stock may have derived from a single capsule.

Zephyranthes flavissima Rav. (Figure 1) inhabits inundated places in the Province of Entre Ríos, Argentina and pastures in the State of Santa Catarina, Brazil. Although under cultivation the plant is evergreen, its cycle is definitely a winter one, with a short, late summer rest. In Argentina it is found in river banks in a mix of gravel and clay soil in full sun. Its habitat is frost free but this species can stand slight frosts without damage. A 16cm clay pot is very adequate for a few plants for they offset freely and also set seed. Seed is papery, as in *Hippeastrum* or the Mexican *Zephyranthes*, and should be sown immediately when ripe. Plants established under cultivation flower in mid-spring and again in their normal flowering season, late summer. Their habitat of standing water can be simulated by placing the pots in a shallow container with water. This can be withheld from flooding for one month in late summer and when resumed, the plants will rapidly flower. Spring flowering is produced without any previous rest. It is one of the more promising species for horticulture, as easy as *Z. candida*, but tests for hardiness are not complete. It appears very adequate for pond cultivation in pots in full sun. As with all the Amaryllidaceae, the plants will only thrive if left undisturbed for several seasons.

Zephyranthes stellaris Rav. (Figure 2) is a winter growing species from subtropical areas of Paraguay and Argentina. It grows in full sun in acid, red clay soils and is difficult under cultivation in pots where it should be left undisturbed to increase by offsets. It also sets seed, as fleshy and round as in *Z. candida* Herb., which should be sown while still plump. The seed seems to retain very little viability once it shrivels. Dormancy in *Z. stellaris* is in summer under very hot dry conditions. For temperatures refer to Table 2 in the first part of these "Notes" (Herbertia 42:59). Foliage in this species seems to be extremely attractive to grasshoppers. It demands frost-free conditions and a minimum of 10 degrees C. during winter for successful cultivation. Flowers are produced in late summer just before leaves.

Zephyranthes minima Herb. (Figure 3) is a tiny but extremely vigorous species that grows in the Provinces of Buenos Aires, Entre Ríos and Corrientes, Argentina. It is a winter grower with summer dormancy. Flowering is in autumn before the foliage appears. Resistance to cold depends on its origin. Those plants from the Buenos Aires Province survive -6 degrees C. without problems. The forms from the northern, subtropical part of their distribution demand frost-free conditions. Reproduction is easy from very fresh seed (roundish as in *Z. candida* and *Z. stellaris*) and the bulbs have not been found to offset. Some from Entre Ríos Province are double in size to those found in Buenos Aires Province, perhaps due to a tetraploid condition. In Corrientes Province, *Z. minima* was found in association with *Haylockia americana* (Hoffms.) Herter (Figure 4) and *Cypella lapidosa* Rav. It grows in full sun in pastures, in alkaline clay soils in Buenos Aires Province. In Corrientes and Entre Ríos Provinces it grows in acid sandy or clay soils.

Hippeastrum ambiguum Herb. ex Hook., is one of the most beautiful species in the genus *Hippeastrum*. Scent in *H. ambiguum* flowers is wonderful. The exact habitat of this species is not known although it is apparently naturalized in northern Cordoba Province. The small quantity of pollen produced seems to suggest a natural hybrid, according to Dr. Hunziker. This plant is a summer grower with a dry winter dormancy. An acid soil and high temperatures are necessary for a successful cultivation. Bulbs grow very large, so a 30cm or larger pot is necessary for them. Reproduction is from offsets, seed apparently not being produced; another evidence suggesting its hybrid origin. A minimum 10 degrees C. is suggested during its dry winter dormancy. Bulbs in the wild are found deeply buried (15cm or more).

Figure 1. *Zephyranthes flavissima*, photo by Gustavo D'Antiochia.

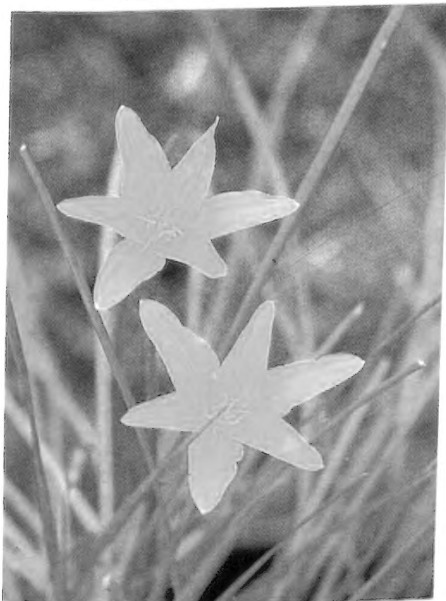


Figure 3. *Zephyranthes minima*, photo by Gustavo D'Antiochia.



Figure 4. *Haylockia americana*, photo by Jorge Veit.



Figure 7. *Onira unguiculata*, photo by Stan Farwig.

Figure 2. *Zephyranthes stellaris*, photo by Jorge Veit.



Figure 5. *Hippeastrum aulicum*, photo by Jorge Veit.



Figure 6. *Kelisia brasiliensis*, photo by Stan Farwig.



Figure 9. *Cypella lapidosa*, photo by Gustavo D'Antiochia.



Hippeastrum aulicum (Ker-Gawl.)Herb. (Figure 5) is a Brazilian species that is almost evergreen but with a winter season of growth. Flowering is in early winter. A short period of dormancy in autumn precedes the appearance of a new set of leaves. This is one of the easiest *Hippeastrums* in mild climates as it can stand temperatures that may prove harmful to most species in winter. It is very often found growing as an epiphyte with large root systems. It thrives under cultivation in large pots. A fibrous compost with tree fern fibre is suitable. The bulb should be planted with its upper half exposed, as in the wild. An acid soil and a light position in shade is necessary.

Kelissa brasiliensis (Bak.)Rav. (Figure 6) inhabits certain parts of the State of Rio Grande do Sul, southern Brazil. It is one of the most beautiful of all the Iridaceae, flowers being huge for the size of the plant. Its habitat in the wild is practically subtropical and it grows in full sun in acid red clays. It is found in association with a *Drosera* sp. which may indicate a soil extremely poor in nitrogen and of a low acidic pH. Therefore, normal fertilizers may prove harmful to these plants in providing excessive amounts of nitrogen. Although plants are very occasionally found to offset, reproduction is from seed which is produced abundantly and should be sown in autumn under frost-free conditions. *Kelissa* is a very vigorous grower but it is very rare now in the wild due to the high demand for vacant fields that wheat and soybean production make in southern Brazil. It is of interest to mention that land suitable for agriculture as we think of it is only found in three states of southern Brazil, the rest of the country being situated under a climate too hot or too hot and dry. Therefore, the present and future trend is to use every available square inch for agriculture. Since these subtropical soils are so poor in nitrogen, urea is used to render them fertile and one can not help but wonder if this and other chemicals may not even assist to the destruction of these unique species. *Kelissa brasiliensis* is a winter grower under frost-free conditions and high temperatures are necessary during its summer dormancy or the plants will not sprout again next autumn but remain dormant. Summer rains or watering are not harmful to these plants.

Onira unguiculata (Bak.)Rav. (Figure 7) is another endangered species that shares the same habitat and fate as *Kelissa brasiliensis*. No picture can capture the opalescent sheen of the tepals in *Onira unguiculata*. Also the smokey light blue of *Onira* flowers is too subtle for film. This is a winter grower with a hot summer dormancy and grows in the same acid red clay in full sun in pastures. Very few plants remain in the wild and only where the plow can not reach; usually at the very banks of streams. This species demands strictly warm conditions and is not as easy as *Kelissa brasiliensis* under cultivation. Reproduction is from seed which is produced in abundance if the growth conditions are adequate. A very hot baking during its summer dormancy is necessary to trigger growth. Soil pH is low and soil mixes and fertilizers should be very low in nitrogen. Plants raised from seed are obviously more suited to tolerate different conditions. This species hails from southern Brazil.

Cypella armosa Rav. (Figure 8) inhabits certain places of the Province of Corrientes and Misiones, Argentina. It is a winter grower under frost-free, almost subtropical conditions and is dormant in summer when temperatures are very high. For these refer to the aforementioned Table 2. Reproduction is from seed as this species has not been found to offset. Some plants have flowers orange colored as in *Cypella herberti* Herb. and others a lemon yellow as shown in Figure 9. Under cultivation and in the wild this species, *C. herberti* and others of the same group flower in autumn and again in spring. It grows in pastures in acid red clay soils in full sun. It is rare in the wild and colonies usually comprise a few individuals only.

Cypella lapidosa Rav. (Figure 9) is restricted to a region with rocky outcrops in the northeastern Corrientes Province, Argentina and is now very rare due to intensive agricultural practices. As its name indicates, it is found in shallow rocky outcrops that get very hot in summer. This species grows during winter under absolutely frost-free conditions and demands a hot baking during summer while dormant. Full sun and acid red clay soils are its habitat in the wild; also rains occur the year around. In mild climates such summer baking can be provided by placing the pots on a patio in full sun for a month at least, and this has proved adequate to trigger growth in autumn. Flowering is in autumn and again in spring. Temperature range is shown in Table 2, but will stand far higher figures due to its habit of growing in rock crevices exposed to full sun.

Cypella hauthali R. C. Foster ssp. ***opalina*** Rav. (Figure 10) is a taxon that inhabits the northeast corner of Corrientes Province, Argentina. It is a winter grower with summer dormancy under very hot conditions. Exposure is in full sun in acid red clay soil in a subtropical habitat. It is a vigorous species which flowers abundantly in spring. Unfortunately it only survives in a few colonies due to the intensive plowing of fields for cattle raising, pine planting, and artificial pastures. For this latter use, African grasses are imported and many species are disappearing as this practice spreads. Reproduction is easy from seed sown in fall. It can take summer rains without problems while dormant, but high temperatures are important during that period to trigger the following seasons growth.

Herbertia amatum C. H. Wright (Figure 11) inhabits the southwest corner of the State of R  o Grande do Sul, Brazil and the northeast corner of Uruguay (Department of Tranqueras). It is still abundant in those places where agriculture has not become extensive but it has disappeared in the last few years in the north part of its original habitat. A particularly beautiful form was found in the northeast corner of Uruguay, with rounded, outer tepals suggesting a very pretty *Tigridia*. All the area is heavily overgrazed and it is uncertain how many plants of this form remain in the wild. The Brazilian form is slightly different in the shape of the outer tepals that look squarish. Both forms grow under hot subtropical, frost-free conditions during winter and are dormant in summer. Flowers are produced in spring. *Herbertia amatum* is very vigorous and can be easily raised from seed sown in fall, the bulbs not offsetting. Destruction of wild populations in Brazil has been so rapid in the last three years that it is difficult to see one in previously known places where in the past many thousands could be found along the roads. The Uruguayan population is very small and obviously the remnant of a larger one whose boundaries are difficult to ascertain.

Gelasine uruguaiensis Rav. (Figure 12) is a winter grower with summer dormancy, flowering in spring. This species is found in two regions of Uruguay and there are seemingly two populations or forms that vary slightly in flower size. The eastern population being larger, more vigorous and having flowers with undulated tepals. The western-most form is extremely rare in the wild as it inhabits patches of a peculiar white sand in a region heavily overgrazed. There is no chance for this species to survive where cattle can reach. The few remaining specimens were found along roads but since stray cattle were found roaming the area it is doubtful that they will survive. The eastern population is more robust and easier under cultivation, setting abundant seed that germinates readily when sown in autumn. It is evident that this species in its eastern form will be firmly established under cultivation in a short time. It remains to be seen which will be the fate of the smaller, typical western population, named ssp. *uruguaiensis*. The western population has been named *G. u.* ssp. *orientalis*. Both forms grow in open pastures with acid soils. Temperatures in the wild are mild, not subtropical and the plants can take slight

Figure 8. *Cypella arnosa*, photo by Gustavo D'Antiochia.



Figure 11. *Herbertia amatorium*, photo by Stan Farwig.



Figure 12. *Gelastine uruguayensis* ssp. *orientalis*, photo by Stan Farwig.

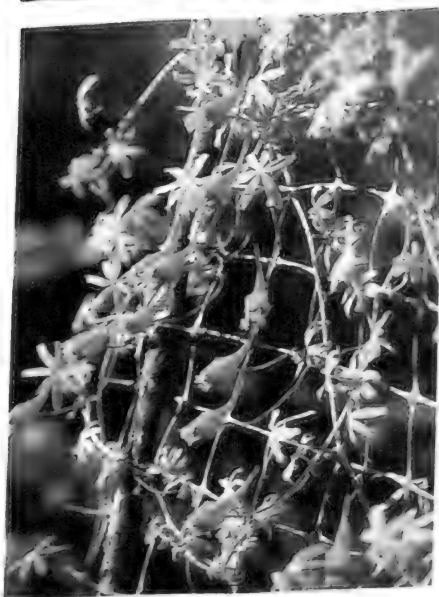


Figure 15. *Tropaeolum tricolor*, photo by Jorge Veit.

Figure 10. *Cypella hauthali* ssp. *opalina*, photo by Brian Mathew.



Figure 13. *Catila amabilis*, photo by Gustavo D'Antiochia.



Figure 14. *Calydorea azurea*, photo by Gustavo D'Antiochia.



Figure 16. *Hippeastrum petiolatum*, photo by Jorge Veit.



Figure 17. *Hippeastrum iguazuenum*, photo by Jorge Veit.

frosts without problems. Also the occurrence of summer rains while the plants are dormant are of no consequence.

Catila amabilis Rav. (Figure 13) inhabits an area of the Province of Entre Ríos and Corrientes, Argentina and the Departamento de Salto, Uruguay. It is a winter grower with summer dormancy. Flowers are produced in autumn and again in spring. It is of interest to mention that there are what could be called two ecological variants. One inhabits the gallery forests of the Uruguay river banks under hot humid subtropical conditions and in deep shade. These plants demand constant high temperatures and are intolerant of cooler conditions. In the other habitat, epiphytic *Oncidium* orchids are found in inland habitat pastures in full sun and here the plants are exposed to slight frosts while growing. As you may have guessed this second form is the easier under cultivation. Both variants are exactly the same in shape and size; it is only their adaptability to different conditions that make them distinct. Reproduction is from seed sown in autumn. *Catila amabilis* is a beautiful vigorous species easy under cultivation in acid soils.

Calydorea azurea Klatt (Figure 14) inhabits an area around the city of Concepción del Uruguay, Entre Ríos, Argentina. Although probably formerly widespread in the area, it is now very seldom seen. It is a winter grower with summer dormancy. Its habitat is mild in a practically frost-free area. It flowers in spring and also in autumn in some years. Star-shaped flowers, wiry stems and very narrow foliage is typical of several *Calydorea*s inhabiting eastern Argentina, Uruguay and southern Brazil. This species inhabits open pastures in full sun in acid clay soils. Reproduction is from seed sown in autumn.

Calydorea pallens Griseb. inhabits a large region of northwest Argentina, mainly in hot places but it is also found at higher elevations in cooler places. This species is a summer grower in full sun in mainly alkaline soils in the wild. Dormancy is in winter under very dry conditions and protected from frost. Reproduction is from seed sown in spring and that is very abundantly produced. Seedlings can be grown under very wet conditions suggesting its native habitat may be seasonally inundated.

Herbertia tigridioides (Hick.) P. Goldblatt is a summer grower from Northwestern Argentina and from Bolivia. It grows in full sun in soils that are mainly alkaline. It is very easy to grow and flower in mild climates. It can take slight frosts during its dry winter dormancy with no harm. Reproduction is very easy from seed sown in spring.

Tropaeolum tricolor Lindl. (Tropaeolaceae) (Figure 15) is a member of a fascinating group of Chilean species of this poorly known genus. This species is a winter grower with a season of flowering in spring. Dormancy is in summer under very dry conditions. This species grows and flowers perfectly in 16cm or larger clay pots. An alkaline mix with coarse sand and crushed rock is perfectly adequate. Drenching with a Benlate solution in late spring as the foliage is yellowing will help preserve the tuber from fungi during its dormancy, its most critical period under cultivation. A few twigs inserted close to the pot edge will assist the plants' climbing. Reproduction is from seed sown in autumn in a porous mix. Seedling tubers are normally found at the bottom of the pot looking very much like an aspirin as it seeks depths during its first seasons of growth. Cool nights, but desirably frost-free, are perfectly suitable for this species. It is very long lived, flowering reliably as long as it enjoys a dry dormancy.

Haylockia americana (Hoffmanseg) Herter (Figure 4) is a winter grower in a hot subtropical area in eastern Argentina and northern Uruguay. Dormancy is in summer under very hot conditions. It inhabits open pastures and rocky outcrops in acid soil and full sun. Reproduction is easy from seed sown immediately after ripening. *Haylockia*

americana flowers in autumn with the ovary subterranean, something typical of this genus. Flowers fade and disappear and there is no evidence of seed setting until after a rain when the capsule emerges, suddenly shedding the seed in a morning's time. One has to be very careful and watch the plants closely after flowering and for approximately a month until the capsules emerge in order to harvest the seed before it is dispersed by the wind. Seed is papery and black as is the case in so many South American genera like *Hippeastrum*, *Zephyranthes*, *Phaedranassa*, *Stenomessonia*, *Habranthus*, and *Worsleya* and has a short viability. It should be sown in sterilized soil for better results. This species must be grown under hot conditions the year round. A 16cm clay pot can contain several plants during several years without problems. Again, as with all Amaryllidaceae they should be left undisturbed for as long as possible in order to develop a sound root system. Some clones bear deep yellow flowers, others an attractive cream color.

***Hippeastrum petiolatum* Pax.** (Figure 16) is a summer grower with dry winter dormancy in a subtropical area along the Uruguay river basin. A natural triploid, it never sets seed. It propagates itself by means of offsets that are produced abundantly and that can float in water. This suggests the way this species spreads with seasonal floods. These bulblets have a long period of dormancy and would not sprout until the next season of growth. This will enable them to travel long distances before "anchoring" when the flood season is over. Its southern-most population is at Punta Lara forest, 100km south of Buenos Aires, a narrow, subtropical area along the Río de la Plata. This species, formerly abundant, is now seldom seen due to the felling of their native forests. High temperature, shade, as in the wild, and acid soils are necessary for its cultivation. Wild plants are found with the bulb barely covered. Under cultivation it can be grown this way or even with half the bulb exposed. Broad, short leaves are typical of *Hippeastrum petiolatum*. Completely frost-free conditions are important during its winter dormancy. Extremely susceptible to virus diseases, this species can not be renewed by seed setting. Therefore, plants and cultivating tools should be maintained scrupulously clean and insect free.

***Hippeastrum iguazuianum* Rav.** (Figure 17) inhabits a region of the northeastern portion of the Province of Misiones, Argentina. It is a summer grower with winter dormancy. Subtropical habitat indicates frost-free conditions during dormancy. Acid soils and light to deep shade are indicated for growing. Reproduction is presumably from seed although plants in cultivation have not produced it yet. Offsets are produced regularly every year. Wild plants are found with the bulb some 10cm deep. Although this is rather scarce in the wild, its extreme similarity to a species from Salta Province, Argentina, i.e. *Hippeastrum aviflorum* Rav. may suggest an intergradation along the same latitude and that other populations may be found in between. Flowers of *H. iguazuianum* are typical of the shape of this whole group of species in the genus. Leaves of this species are easily recognizable; they are glaucous, pruinose, keeled and with the edges folded back.

SOME AUTUMN-FLOWERING BULBS OF GREECE

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IN THE Mediterranean lowland little or no rain falls in the hottest period of the year (June to mid-September), and the plants of that region have evolved various mechanisms to cope with summer drought either by enduring or by escaping it. The flora is characterized by three main life-forms:

(1) Evergreen, sclerophyllous shrubs constituting the dominant element of the vegetation (macchie, phrygana, garrigue). Growth and flowering may take place at any time of the year except in midsummer when plants are semi-dormant. Small, hard leaves, often with a wax cover or stomata sunk into cavities constitute adaptations against water loss. Many of the shrubs are spiny or aromatic as a defense against grazing.

(2) Geophytes, i.e. perennials with underground storage organs which produce vegetative growth and flowering in the wetter periods of the year, and die down completely in summer. Most of the "petaloid monocots" belong to this category.

(3) Annuals which complete their life cycle in less than one year, mostly flowering in the spring and surviving the hot, dry summer as dormant seeds. Most of the weeds of the disturbed or cultivated habitats belong to this category, and their predominance in the Mediterranean basin is undoubtedly associated with the development of agriculture which in this region has a history of perhaps 10,000 years. Many have been introduced in to other parts of the world with a Mediterranean-type climate (California, C Chile, the SW Cape region of South Africa, SW and S Australia).

Morphologically the underground organs of the geophytes may be of different nature (rhizomes, bulbs, corms, tubers) serving, however, the same ecological function, i.e. to store water and nutrients through the period of summer drought. The commonest annual life cycle includes flowering and rapid seed maturation during spring and early summer (March to June); above-ground parts of the plants have usually completely died down by midsummer, new leaves are produced in response to the autumn rains which usually start in the first half of October, vegetative growth occurs throughout the usually frost-free winter, and flowers are produced again in spring. The display of crocuses, anemones and orchids in the olive groves and hillsides of Greece from February to May testifies to the importance of this element in the flora and vegetation.

However, in a number of taxonomic groups, mostly among the monocotyledons (*Crocus*, *Sternbergia*, *Colechicum*, *Scilla*, *Urginea*, *Narcissus*, *Galanthus*, *Bianum*, etc.), but including also a few dicotyledon genera (*Cyclamen*, *Ranunculus*) certain species have developed a different seasonal pattern. They flower in the autumn (September to December), often without leaves, vegetative growth takes place in the winter and spring, seed maturation is slow and often not completed until May or June, the plants are dormant throughout the dry hot summer, and flowers are produced again following the autumn rains. In some genera, like *Galanthus* and *Ranunculus*, autumn-flowering is

Figure 2. *Crocus niveus*. Olive grove in the Mani Peninsula SSE of Kalamata. 14.11. 1986.



Figure 4. *Crocus goulinyi*. Mani Peninsula near Areopolis. Cultivated in greenhouse in Copenhagen Botanic Garden, 19.11. 1981.



Figure 11. *Sternbergia lutea*. Vikos Gorge by Mt. Timfi (northern Pindos), ca. 400m. Cultivated in Copenhagen Botanic Garden, 24.10. 1984.



Figure 12. *Sternbergia colchiciflora*. Mt. Parnassos, ca. 1900m. Fruiting individual cultivated in Copenhagen Botanic Garden, 4.5. 1984. Note unripe capsules sitting on the ground.

Figure 1. Flowering times for species and subspecies of *Crocus* (horizontal axis: months; vertical axis: number of taxa). Note the peaks in spring and autumn, with some taxa flowering in winter and very few (from high mountains) in summer. Data from Mathew (1982), with minor additions.

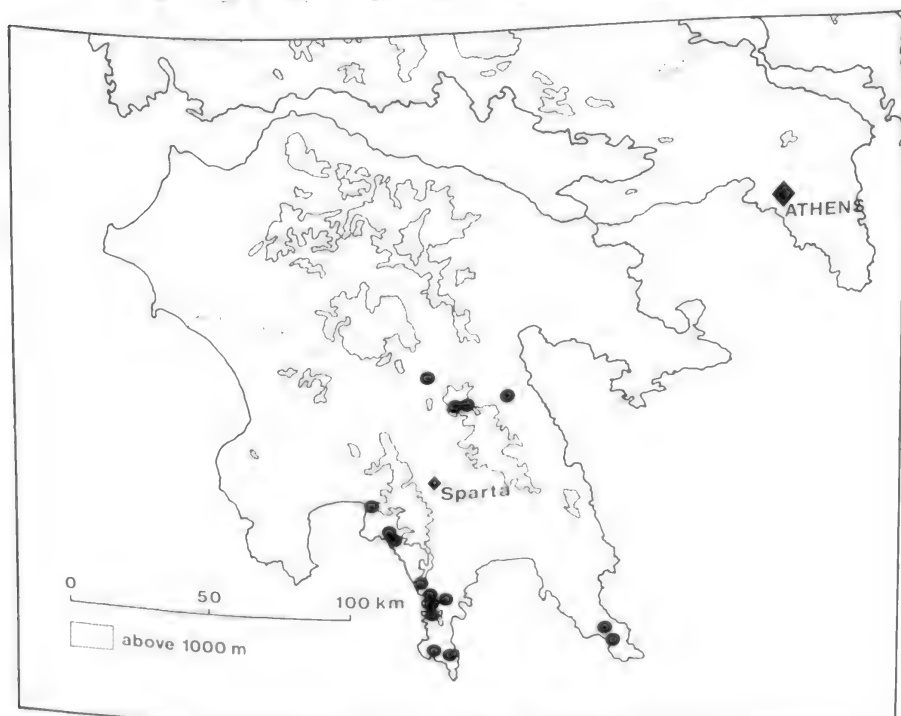
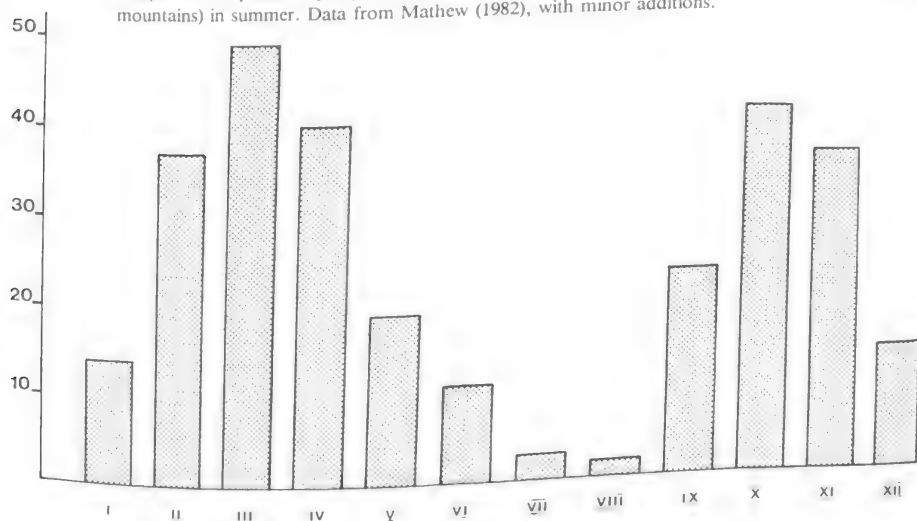
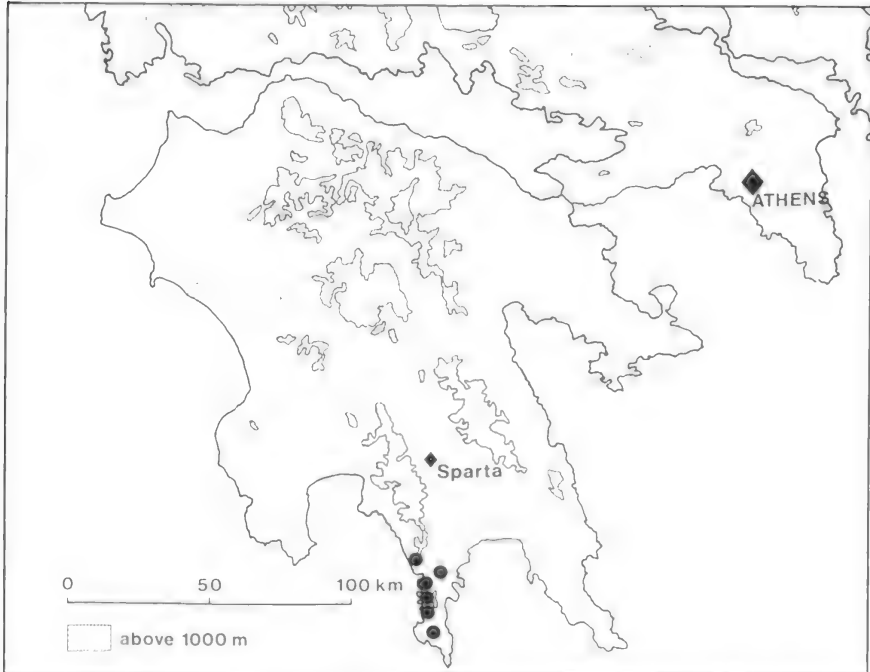


Figure 3. Total distribution of *Crocus niveus*. After Sfikas (1986).

Figure 5. Total distribution of *Crocus goulmyi*. After Stikas (1986).

rather an exception (*G. reginae-olgae* Orph., *R. bullatus* L.); in others, such as *Colchicum*, it has become the dominant pattern.

By becoming autumn-flowering these species have exploited a semi-vacant ecological niche where, for instance, competition for pollinators may be less severe. It may be assumed that many of the geophytes flowered in the winter in periods when the climate was slightly milder. With winters becoming colder or when migrating to higher latitudes or altitudes these plants were faced with selective pressures driving most of them to flower later (i.e. in the spring) and some of them earlier (i.e. in the autumn). This is a powerful mechanism for reproductive isolation; as soon as there is no overlap in flowering time between two segments of a former breeding population, they have reached the point of no return and represent two biological species. In some cases morphological differentiation is still incomplete, e.g. between spring- and autumn-flowering subspecies of the *Crocus biflorus* complex, and between *Galanthus reginae-olgae* and *G. nivalis* L., the former sometimes being regarded as merely an autumn-flowering race of the latter. For obvious reasons of timing, crossing experiments are difficult, and the evolutionary and physiological mechanisms involved are far from clear.

The genus *Crocus* is of particular interest, with approximately equal numbers of spring- and autumn-flowering taxa. The center of diversity is in the eastern Mediterranean area; the excellent monograph by Mathew (1982), from which much of the information on *Crocus* in this article has been taken, lists 80 species in all, some of them with several subspecies. As seen from Figure 1 the peaks of flowering are in March and October; a fair number of taxa are winter-flowering but very few (from snow patches in

Figure 6. Fortified village on the Mani Peninsula. *Crocus niveus* and *C. goulimyi* grow in olive groves such as the one in the foreground. Note also the columnar funeral cypresses (center).



Figure 7. *Crocus horvii*. Peloponnese, hills northwest of Megalopolis, 300m. 13.11. 1986. In one of the flowers three perianth segments have been turned back to show the white anthers.



Figure 8. *Crocus carwrightianus*. Attica, by Vouliagmeni, rocky limestone hills near the sea. 30.11. 1979.



Figure 9. *Colchicum cuprum*. Attica, northern foothills of Pendeli, 400m. 16.11. 1986.

Figure 10. *Colchicum macrophyllum*. Simi (East Aegean Islands), hill just above the harbor. 20.10. 1984.



Figure 16. *Drimia (Urginea) maritima*. Atica, near Vouliagmeni, among limestone rocks. 10.12. 1977. The leaves are now well developed; a dry infructescence is on the right.

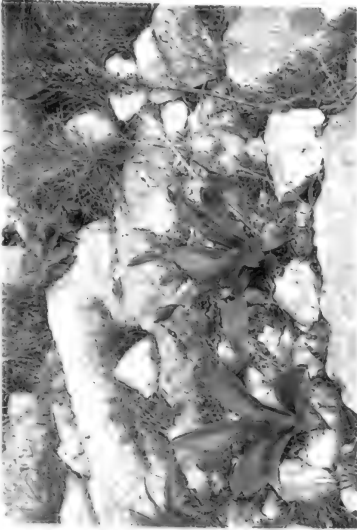


Figure 17. *Arisanum vulgare*. Atica, near Vouliagmeni. Coastal phrygana. 10.12. 1977.



Figure 19. *Biarum davisii*. Leaves have developed rapidly after flowering. Cultivated in greenhouse, Copenhagen Botanic Garden, 17.1 1987 (flowered ca. 10.10.).

high mountains) flower in summer. The autumn-flowering taxa are generally white or pale lilac-blue, whereas the spring taxa have a wider spectrum of colors including some with bright yellow flowers. Undoubtedly this is correlated with the availability of pollinators, but little is known about the details.

At least ten autumn-flowering *Crocus* species occur in Greece: *C. biflorus* Miller (with several subspecies), *C. boryi* Gay, *C. cancellatus* Herbert, *C. cartwrightianus* Herbert, *C. goulimyi* Turrill, *C. hadriaticus* Herbert, *C. niveus* Bowles, *C. oreoreticus* B. L. Burtt, *C. robertianus* C. Brickell and *C. tornefortii* Gay. One species, *C. laevigatus* Bory & Chaub., can be classified as winter-flowering. There is a concentration of species in the south, with center of diversity on the Peloponnese.

Two species, *C. niveus* (Figures 2-3) and *C. goulimyi* (Figures 4-5) are practically restricted to the Mani Peninsula, the central of the three southern fingers of the Peloponnese. This is a very interesting area, botanically as well as culturally. The landscape is austere and dramatic, dotted with defense towers in grey stone and many small Byzantine churches dating back to the 11th and 12th century. The *Maniotes* are believed to be descendants of the ancient Spartans and take pride in being the only Greeks who have managed to defend themselves against all invasions. Throughout the centuries of Turkish occupation they continued their particular life-style with the region divided into captaincies led by a clan chieftan, the small towns bristling with towers like medieval fortresses. This is a region with many botanical treasures including rare local endemics such as *Lithodora zahnii* (Heldr. ex Halácsy) I. M. Johnston (Browicz, 1986) and *Helichrysum taenari* Rothm. (Strid, 1986). *Crocus niveus*, although very restricted in its distribution, is abundant in olive groves throughout much of the peninsula from near sea level to ca. 700m. It is one of the largest of all *Crocus* species, having brilliant white flowers with a yellow throat, yellow anthers, orange-red stigma branches, and fibrous corm tunics. It may grow together with the less common *C. goulimyi* which was first collected by the Greek amateur botanist Constantine N. Goulimis in 1954. *C. goulimyi* has pale lavender-blue flowers with a concolorous throat, and smooth coriaceous corm tunics. A third species sometimes growing in the same localities is *C. boryi* (Figure 7) which looks rather like a small *C. goulimyi*, but is easily distinguished on the white anthers; it is more widespread in southern and western Greece.

Crocus cartwrightianus (Figure 8) was named by W. Herbert after his "excellent friend" Mr. Cartwright who was on the staff of the British Consulate at Istanbul in the early 19th century. It is most probably the diploid ancestor of the cultivated saffron crocus, *C. sativus* L. which is a sterile triploid. *C. cartwrightianus* is common in the hills around Athens, and also occurs on the Cyclades and western Crete. The flowers are concolorous and vary from lilac or purplish to white; the long, red style branches are particularly characteristic. The recently described *C. oreoreticus*, a species restricted to the mountains of central and eastern Crete, is closely related.

Colechicum is a taxonomically difficult genus of the Mediterranean area and southwest Asia with ca. 90 species in all, about 32 of which occur in Greece. Most of them are autumn-flowering; the leaves appear either with the flowers or after (often several months after) anthesis. Flowers, leaves and fruits are often necessary for accurate identification, and since they are normally not to be found on the same herbarium sheet there has been considerable taxonomic confusion. Extensive cultivation experiments and cytotoxic work by K. Persson of the Göteborg Botanic Garden has done much to clarify the taxonomy of the genus, but most of this work is still unpublished.

Most of the species have an oblong to subglobose corm; a few, such as the small *C. psaridis* Heldr. ex Halácsy of the Mani Peninsula (growing together with *Crocus niveus*, *C. goulimy* and *C. boryi*), have a worm-like rhizome, presumably a primitive characteristic. Colors of perianth segments, anthers and leaves are important for identification, and since they are often obscured in herbarium specimens, careful notes should be taken by collectors. Fruit development is generally slow, and in most autumn-flowering species seeds do not mature until the following summer. Only two species will be illustrated here:

C. cupanii Guss. (Figure 9) is widespread in the Mediterranean region and occurs on rocky hillsides at low and medium altitudes throughout southern and central Greece. It is a small plant with 1-5 flowers and 2(-3) leaves appearing simultaneously from each corm; the perianth segments are uniformly pale rosy-lilac, and the anthers dark purplish. It flowers from September to December, whereas the closely related *C. doerfleri* Halácsy is winter- or spring-flowering (January to April according to the altitude).

C. macrophyllum B. L. Burtt (Figure 10) is a very different species occurring on low rocky hills and in open coniferous woodland in Crete, the southeastern Aegean islands and southwestern Anatolia. The brown, coriaceous tunics of the deep-seated corm are prolonged into a somewhat fibrous neck appearing just above ground level. The flowers which are produced in September-October are large, rosy-purple and more or less tessellated. The leaves appear after anthesis and grow slowly throughout the winter and spring; when fully developed they are conspicuously large (ca. 30cm x 13cm), elliptic-ovate and longitudinally plicate, resembling the leaves of *Veratrum*.

Sternbergia is a small genus of the Amaryllidaceae occurring in the Mediterranean region and southwest Asia. Most of the species, including the three that occur in Greece have bright yellow flowers, but a white-flowered species, *C. candida* Mathew & T. Baytop, has recently been found in SW Anatolia. The Greek species are autumn-flowering; in *S. lutea* (L.) Ker-Gawler ex Sprengel (Figure 11) and the closely related *S. sicula* Tineo ex Guss. which both occur at low altitudes the leaves appear with the flowers in October-November; in *S. colchiciflora* Waldst. & Kit. (Figure 12) which occurs in the mountains up to ca. 2000m the flowers appear somewhat earlier (end of August to mid-October) and leaves do not develop until in the spring. In *S. lutea* and *S. sicula* the flowers are held above the ground on a scape which is usually 4-10cm long at anthesis and later becomes recurved, the capsule eventually touching the ground; in *S. colchiciflora* the flower and capsule are sitting on the ground.

Galanthus (snowdrops) another genus of the Amaryllidaceae, is well-known in gardens of central and northern Europe where, together with *Eranthis hyemalis* (L.) Salisb. (Ranunculaceae), it heralds the approach of spring. Four species, *G. nivalis* L., *G. reginae-olgae* Orph., *G. elwesii* Hooker, and *G. ikariae* Baker occur in Greece; all are variable and divided into several subspecies or varieties (Kamari, 1982). Particularly interesting in this context is *G. reginae-olgae* (Figures 13-14) which flowers from mid-September to mid-December and is scattered in Greece and southern Albania (possibly also in southern Italy). It is closely related to the spring-flowering *G. nivalis*, differing principally in the fact that the leaves are lacking or very poorly developed at anthesis and the flowers somewhat larger. The mature leaves of *G. reginae-olgae* are dull green above with a glaucous central stripe; in *G. nivalis* they are glaucous throughout the upper surface. The discovery of a winter- to spring-flowering form of *G. reginae-olgae*, ssp. *vernalis* Kamari, makes the specific distinction somewhat obscure. What we are witnessing may in fact be the most critical phase in speciation due to seasonal differentiation.

Figure 13. *Galanthus reginae-olgae*. Mt. Taygetos, Langada Gorge, ca. 900m, under *Platanus* trees. Cultivated in greenhouse in Copenhagen Botanic Garden, Oct. 1987. Note the lack of leaves at flowering time.



Figure 14. *Galanthus reginae-olgae*. Close-up of flower.



Figure 15. *Drimia (Urginea) maritima*. Rodhos, coastal phrygana near Lindos. 15.10. 1984.



Figure 18. *Biarum davisi*. Three dug-out specimens (total length ca. 12cm). Simi (East Aegean Islands), hills just above the harbour. 20.10. 1984.

A well-known autumn-flowering bulb of the Mediterranean area is the medicinal sea squill, *Drimia maritima* (L.) Stearn (Figures 15-16), until recently known under the name of *Urginea maritima* (L.) Baker (cf. Stearn 1978). Its huge bulbs, often partly exposed and 10-15cm in diameter, are frequently seen on rocky limestone hills in coastal areas of southern Greece. It produces an erect scape 80-150cm tall with numerous white flowers in an elongate raceme appearing from the end of August to mid-November. The plant is completely leafless at anthesis; the large, broadly oblanceolate, shining leaves develop in the winter and spring and die down early in the following summer. The sea squill was well known to the 1st-century Greek herbalist Dioscorides who described its diuretic and purgative properties, notably for patients with "dropsy or with stomachs bloated by undigested food or suffering from jaundice, colic, chronic cough, asthma or bringing up phlegm." In modern times it has been recorded from the Dodecanese (according to Stearn op. cit.) that a piece of mandrake root and a bulb of squill were placed under the pillow or mattress of a newly married couple to ensure fruitful intercourse.

The family Araceae comprises some autumn- and winter-flowering species. A well-known representative is the friar's cowl, *Arisarum vulgare* Targ.-Tozz. (Figure 17) which occurs throughout the Mediterranean area, often in orchards and olive groves where its "snake-head" inflorescences appear from November to April. As with many other members of the family, the inflorescence serves as a pit-fall for pollinating insects (see Koach & Galil 1986). A rare and little-known species is *Biarum davisii* Turrill (Figures 18-19), known from a few localities in Crete, the southeastern Aegean islands and southwest Anatolia. The straw-colored inflorescence, some 4-8cm long, appears in October before the leaves, and may be hard to observe among the dry grass. The flask-shaped spathe withers rapidly, and with the onset of autumn rains the stalked leaves develop and remain green throughout the winter.

The autumn-flowering bulbs of the Mediterranean area constitute a distinctive ecological element and comprise many attractive species. A trip to Greece in October-November, when life has settled after the long, hot and crowded summer, has much to offer the botanist and bulb-grower as well as the general tourist.

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OBSERVATIONS OF *CRINUM AMERICANUM* L.; THE NECHES RIVER REVISITED

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THE lower Neches River of southeast Texas is bordered by broad swamps and densely wooded lowlands. Huge cypress trees once dominated the landscape, but they fell prey to a wooden shingle industry which prospered in the nineteenth century. Today, cypress trees are gradually returning to their pristine glory, thanks to protective legislation which established the Big Thicket Preserve.

My intimate acquaintance with the Neches River was born out of interest in the genus *Crinum*. During an 18 month period, 61 field trips were made into its swamps to compile an in-depth study of *Crinum americanum* L., and indigenous species of East Texas. Most swamps, bayous and logging channels accessible by flat bottom boat in the lower 70km were explored. *Crinums* were found in large numbers within an area encompassing the Beaumont Unit of the Big Thicket Preserve and extending south about 8km beyond the city of Beaumont. Detailed measurements of flowering plants were recorded by date, and selected locations were repeatedly monitored throughout the flowering season. Field investigations were conducted during every month of the year.

The water level of the lower Neches River is partially regulated by major upstream dams. This portion of the river is also subjected to ocean tides, and a daily water level variation of 30cm or more is common. The climate is extremely humid owing to close proximity to the Gulf of Mexico. Annual rainfall is 130-150cm, and the river usually floods several times a year during intense rainy periods. Peak daytime temperature in summer often reaches 35°C, while minimum winter temperature seldom falls below -5°C.

Crinum grow in direct relative position to tidal fluctuations. Plants are physically stationed such that at high tide they are either partially or completely immersed in water. During low tide only a small number still have lower portions of the leaves covered with water. Whenever the river floods, plants are completely submerged for periods up to several weeks without any deleterious effects. *Crinum* are most abundant in swamps which communicate with the river through bayous, lakes and logging channels.

It requires a boat to adequately study *C. americanum*. Plants flourish in clay muck, and if you should attempt to walk through it in boots, you would quickly find yourself buried up to your knees and stuck. The muck is acid and has an approximate 5.5pH. The combination of a flat bottom boat and duck poles (3m wooden poles with spring loaded frog feet on one end) permits exploration of remote swamp areas which are unreachable by any other means, even by canoe. Less than 15cm of water is required, and portage over fallen tree trunks and cypress stumps is possible with minor difficulty. It is in such places that the grandeur of *Crinum* abounds, especially in the Scatterman Lake swamps of the Big Thicket. Snakes are only a problem in the spring, but they do not constitute a hazard as long as one remains in the boat. Protective snake boots are a must whenever

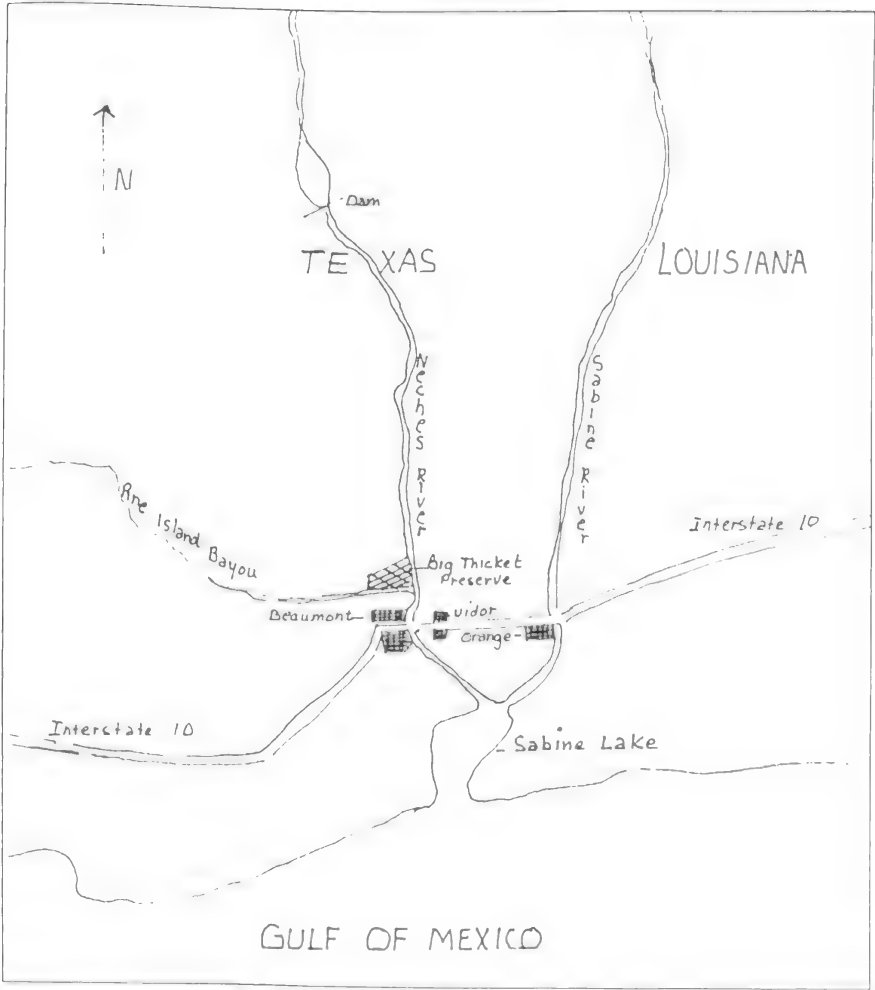


Figure 1. Sabine-Neches Watershed of Southeast Texas.

Figure 2. *Crinum americanum*. Cypress swamp west of Scatterman Lake, Big Thicket Preserve, Neches River. September 20, 1986. All photos by the author.



Figure 3. *Crinum americanum*. Shoreline of Scatterman Lake, Big Thicket Preserve, Neches River. September 17, 1986.

exploring higher inland areas because diamondback rattlesnakes are common. I have not yet encountered an alligator during my outings, which is a remarkable achievement according to river folk.

In the Big Thicket, *Crinums* thrive in shady swamps beneath a dense canopy of cypress and gum trees. Coexisting vegetation consists mainly of *Hymenocallis liriosme* (Rafinesque) Shinnery and species of Iridaceae. South of Beaumont, few trees populate the swamps, and consequently there is an intense proliferation of tall marsh grass and leafy vegetation. *Crinums* cannot effectively compete in this environment and are often difficult to identify until December after the grass has died.

Crinums located in open sunny places generally have small erect leaves and are grouped together in densely populated colonies. In contrast, plants growing in shady swamps are not as closely spaced and have leaves that are larger, arching, strap shaped, darker green and greater in number. Leaf predators may drastically alter plant appearance. Caterpillars and grasshoppers can locally reach epidemic proportions and completely defoliate large tracts of *Crinum* and *Hymenocallis*. Periodic river flooding is the major natural control of these insects.

Summer-flowering scapes are green to dirty grayish-green. In late autumn, they take a reddish pigment. The rust-red color is initially detected in the proximal scape. As the weather cools and days become shorter, pigmentation may spread throughout a scape and extend into ovaries, tepal tubes and spathe valves. It is variable though, and some plants only produce entirely green scapes. Plants bearing dirty grayish-green scapes in summer make reddish scapes in autumn.

A different red color is observed in flower buds. It occurs in the distal bud and is deep pinkish-red. It is also seasonal and variable. Until the weather cools, it bleaches out after exposure to sunlight. In November, it may persist throughout budding and then gradually fade to light pink on the outer tepal surface in mature flowers. Sepals are more prominently colored than petals. If tepal pigment is produced, a *Crinum* colony in bloom has light pink flowers when viewed at a distance.

Cool temperatures of late autumn also herald other changes. Although scapes remain sturdy, the flower complex undergoes stunting which is not uniformly distributed among individual flower components. It is common to encounter flowers where tepal tubes are shorter than tepals and styles shorter than filaments. New leaf growth is retarded, and plant stature gradually declines as the older, larger leaves decay. By December, scapes may develop on plants which only have battered leaf stubble remaining. A casual observer who compares a summer flowering plant with luxurious arching foliage and green scape to a late autumn plant with sparse foliage, red scape, short tepal tubes and pink tepals would surely conclude that two different *Crinum* species existed.

The leaves of *C. americanum* are deciduous. Bulbs sprout new leaf growth in late February to early March. A few residual scapes formed the previous year briefly bloom during March, but the inflorescences are inferior. Leaves continue to increase in size and number until autumn, provided weather conditions are favorable. Normal scapes arise in early June south of Beaumont and several weeks later in the Big Thicket. Flowering scapes are most numerous during July. In the south, competing vegetation smothers *Crinum* plants by August, and flowering diminishes or ceases until late autumn when the marsh grass dies. Shaded colonies in the Big Thicket continue to flower throughout the summer and autumn. However, a protracted hot dry spell will turn off the flowering clock as will widespread insect damage. An average flowering size bulb produces 2 or 3

scapes a season, which are spaced at intervals. Both leaf size and number per plant begin to decrease in October, although a second surge in scape activity occurs in November. Winters are mild, and the river never freezes. Plants tolerate light frost which sporadically happens in early December. Even freezing weather does not drastically affect plants if the water level is high. Dwindling numbers of scapes are produced into December until the first major arctic cold front passes through the region, usually by late December or early January. The cold front is accompanied by strong northerly winds and high barometric pressures, both of which drive water out of tidal bays into the Gulf of Mexico, thereby creating super-low tides. This exposes the entire leaf structure to a killing freeze, and a dormant period ensues until spring.

Bulbs are stoloniferous and multiply rapidly. Stolon length appears to be a function of soil stratum and topography, because atmospherically exposed bulbs only produce stolons a few centimeters long. Some stolons travel horizontally underground and others are deep diving, which may be due to local obstructing factors such as adjacent stolons and nearby bulbs, roots and rocks. It is not an easy task to trace the paths of stolons in clay muck, particularly if cypress roots are present. Stolons are delicate and break under minimal stress. I once carefully dug one intact which was 85cm long, its mid-portion lay 20cm beneath the surface, and there was a kink where it made an abrupt right angle turn away from a tree root. Newly formed stolons arise just above the basal plate. If a bulb originated from a stolon, there is often a residual stolon stump inferior to the basal plate. Apparently there are instances where the parent stolon persists and continues to function long after the bulblet has become established, and as a result, a long tapering basal plate is formed which resembles a carrot.

Bulb length and diameter are partially a function of how much silt, if any, is deposited over a bulb during its lifespan. At one location, I dug bulbs which had been buried under a thick layer of sediment. They were very long, slender and cylindrical in contour.

New leaves arise in the bulb's center and characteristically have folded lateral margins. Both margins are tightly folded to the same side of a leaf almost like storm shutters, with one margin slightly overlapping the other. After unfolding, two parallel creases remain in the distal leaf throughout its lifespan. Leaves are channeled and thicker in the middle. Margins contain numerous, closely spaced, minute spikes or teeth. Most leaf tips are bluntly acute, asymmetrical and have slightly curled margins such that the shape would hold a few drops of water much like a small scoop.

The scape emerges at the bulb neck inside one of the older decaying leaves. It has an elliptical cross section and is compressed near the bulb. A young scape is brittle and readily snaps in two. It later acquires longitudinal fibrous tracts which resist breaking. As seed pods enlarge, weight eventually becomes too great, and the scape falls to the ground or onto adjacent plants. Seed pods are buoyant, and fallen scapes rise and fall with the tides.

The flower complex in a young scape is completely enclosed by two membranous spathe valves. One is larger (major), and its margins overlap the smaller (minor). Spathe valve tips are either bluntly acute or truncated. Lateral margins enfold after they are spread apart by emerging buds. They are usually green but may show streaks of red pigment in autumn.

A distinct, measurable pedicel is seldom evident. The ovary is darker green than either the scape or tepal tubes. It expands after fertilization and develops a fibrous capsule surrounding the seeds. Approximately 85% of the tepal tube persists as an ovarian apical projection. Individual seeds can be quite large, particularly when only one or two are

TABLE 1. Number of flowers occurring per inflorescence.

FLOWERS PER SCAPE	NUMBER OF SCAPES OBSERVED
1	1
2	13
3	37
4	119
5	38
6	9
7	2
TOTAL	219

TABLE 2. Physical measurements of *Crinum americanum* recorded from the Neches River during the months of July through September, 1985-86. The insert lists comparable data obtained from October through December.

STOLONS— Number per bulb: 0—(2)—8

BULBS— Diameter: 2.9—(4.7)—7.0cm
 Length excluding basal plate: 5.0—(9.6)—22.0cm
 Length of basal plate: 1.0—(3.1)—11.5cm

LEAVES— Number per plant: 3—(7)—14
 Maximum length per plant: 25—(75)—132cm
 Maximum width per plant: 1.9—(4.2)—6.5cm

SCAPE— Length: 26—(57)—104cm SPATHE VALVES— Length major: 6.7—(7.9)—10.2cm
 Length minor: 6.2—(7.7)—9.7cm
 Width major: 1.6—(2.2)—2.8cm
 Width minor: 1.3—(1.9)—2.7cm

OVARY/PEDICEL— Length: 1.3—(1.9)—2.8cm
 Width: 0.5—(0.8)—1.0cm

OCTOBER THROUGH DECEMBER

TEPAL TUBES— Length: 7.0—(12.1)—15.5cm	5.8—(10.2)—14.2cm
SEPALs— Length: 7.3—(10.3)—13.1cm	6.9—(9.2)—13.0cm
Width: 0.9—(1.5)—2.4cm	1.0—(1.4)—2.1cm
PETALS— Length: 7.1—(9.9)—12.8cm	6.5—(9.0)—12.5cm
Width: 1.0—(1.7)—2.3cm	1.0—(1.5)—2.2cm
STYLE— Length: 3.5—(7.9)—12.0cm	2.7—(6.6)—10.0cm
FILAMENTS— Length: 4.2—(5.8)—7.4cm	3.9—(5.1)—6.4cm

ANTHERS— Length at dehiscence: 1.7—(2.0)—2.4cm

SEED PODS— Maximum diameter: 4.0—(5.1)—8.5cm

SEEDS— Number per pod: 1—(3)—8
 Maximum diameter: often exceeding 3.0cm; largest 5.8cm

OVARIAN APICAL PROJECTIONS— Length: 6.5—(10.5)—14.0cm

formed in a single pod. When few in number, they resemble flattened green ovoids and often exceed 3.0cm in maximum diameter. Seeds float in water and are carried either upstream or downstream depending upon currents, tides and wind. They germinate at high tide marks along shorelines or at random in shallow swamps.

Most inflorescences contain between 2 and 6 flowers as illustrated in Table 1. The average is 4 flowers. Uniflower scapes are diminutive, associated with small bulbs, and probably represent initial scapes in young plants. Only once have I observed a scape with 8 flowers.

Immature buds are closely packed together and erect. They are greenish-cream colored with red tips, although a large portion of distal buds can be pinkish red in autumn. As growth commences, buds spread apart so they are no longer perfectly erect, and the green hue disappears. When appropriate growth has occurred, the distal tepal tubes bend, causing buds to droop. Within 24 hours in summer, bud tips point directly at the ground. They then puff up slightly, turn white and ascend. They open in early evening hours when nearly in horizontal position. The opening or spreading of tepal segments happens suddenly, and within seconds a cone shaped array of pointed tepals appears. Tepals rapidly open to a reflexed posture over a period of several hours. During this time, the flower continues moving upward to a suberect stance. The distal tepal tube is usually left with a slight curve or bow. Duration of the drooping and opening stages is considerably prolonged in cool weather. If the ambient temperature falls to 5°C or less, drooping does not happen, and tepals do not recurve.

The distal style is purple and has no discernable stigma. The proximal style enclosed within the tepal tube is white. Depending upon the growth relationship between tube and style, there may or may not be a short segment of white style exposed in mature flowers; usually there is. Short styles remain centrally located in the flower throat. Long styles are inclined and mildly bowed in the middle.



Figure 4. *Crinum americanum* nestled among cypress roots. Cypress swamp west of Scatterman Lake, Big Thicket Preserve, Neches River. September 20, 1986.

Figure 5. *Crinum americanum* exhibiting red pigment. Low tide, shoreline of Clark's Island south of Beaumont, Neches River. December 28, 1986.



Filaments are straight and tightly bunched inside erect buds. During the drooping bud stage, their distal ends become coiled and resemble fishhooks with anthers stuck on their tips. They uncoil when the flower opens, spread apart, and assume a bowed configuration which is cup-like in contour. The distal two thirds is pink to purple, while the proximal one third is white.

An immature anther is light gold and large in comparison to the filament and style. It reaches maximum size in the early drooping bud stage where it becomes tan in color. In the late drooping bud stage, bright yellow pollen begins to mature. The anther quickly shrinks and turns black after the flower opens.

Tepal segment shape varies between slightly lanceolate to slightly oblanceolate. Sepals are longer and narrower than petals if adjacent tepals on the same flower are compared. Tepals are apiculated, and the pointed tip of the sepal is more conspicuous than the petal. The petal tip is red or pinkish-red, while the sepal tip can be red, reddish-green, or green with a tiny red dot on the point. In summer, a flower retains sharp tepal detail for only one day, whereas several days are possible during cool weather.

Three pollinators have been observed: hummingbirds and solitary bumblebees during the day, and black moths in the twilight hours. It is feasible that spontaneous self pollination occurs due to the unique geometry of the flowering process. In hot weather, pollen begins to shed from anthers in the drooping bud stage. With the flower bud temporarily in vertical position, pollen is directed into the funnel shaped region of the bud tip where the stigma is located. If the stigma is receptive to pollen at this time, self pollination would be possible.

Occasionally seeds are carried to high ground during a flood and germinate. Subsequent plants are stunted from lack of sufficient moisture. If water is nearby and sporadic bathing occurs during super-high tides, leaves develop to be suberect, stiff, short and much broader than expected for length. Should plants be well removed from water or exposed to protracted dry spells, leaves become near horizontal and may even lie flat on the ground. Margins tend to roll up, and leaves may look like scrolls. The overall morphologic alterations can be very striking. Aridity stunting is seasonal. Springtime is usually wet. Plants do not demonstrate aberrant development until exposed to drier summer heat. Field observations commenced in July, 1985. It did not rain the entire month of August. In September, a group of *Crinum*s were discovered growing in high dry ground on Clark's Island. I was immediately impressed that these had to be another species of *Crinum* because the leaf structure was so disparate. Only after monitoring plants through the following moist spring, observing them in flower, and transplanting bulbs was I satisfied they were indeed *C. americanum*.

Listed in Table 2 is a compilation of measurements obtained during the warm months of July through September. Where appropriate, they are listed as: smallest value—(mean value)—largest value. No attempt was made to segregate plants according to sun exposure or shade. The high and low extremes reflect the degree of variability which occurred. A similar analysis was accomplished for the cooler periods of October through December. A limited sample of cool weather data is included as an insert to illustrate temperature effect.

I cultivate a modest collection of Neches River *Crinum*s at home. They are raised in muck dug from the Neches River lowlands. Regardless of weather bulbs are grown in clay pots with a water saucer or in a swamp garden, plants are stunted in comparison to their counterparts in the river. Plants look healthy, flower regularly, have greater numbers of leaves, and make numerous stolons, but they uniformly have smaller leaves, scapes and flowers.

I studied *C. americanum* in the Sabine River at the Texas and Louisiana boundary, and also in the Trinity River 80km west of Beaumont. Although the river bank and aquatic habitats were different, I was not able to identify any distinct variations among indigenous *Crinum*. In addition, I explored portions of the Dog River in southern Alabama, the Suwannee River of western Florida, and the Big Cypress Swamp of south Florida in October, 1986. I could not distinguish any measurable differences in native *Crinum* from those growing in the Neches River.

DISCUSSION

Neches River *Crinum* have been previously described in **Plant Life** and **Herbertia** on multiple occasions. Traub (1958) reported on bulbs sent to him by Henry, who had collected them approximately 8km north of Beaumont in Hardin County. Traub (1957) cultivated the bulbs in Southern California according to his published culture method for *C. americanum*; bulbs were planted in clay pots filled with amaryllis potting media and placed in water filled saucers. He stated that several specimens were typical *C. americanum*. However, one bulb retained its leaves in the fall when the others went dormant, and it produced a 7 flowered scape in November, 1957. The subsequent seed pods had antenna-like projections. A tentative identification of "robust form of *Crinum americanum*" was made. A photograph of the plant was published with the article.

The reported bulb collection site of Henry corresponds to the Pine Island Bayou region of the Big Thicket. Numerous *C. americanum* populate the banks of the Pine

Island Bayou for several kilometers prior to its junction with the Neches River. Traub's photograph shows a typical moisture and temperature stunted *C. americanum* with short, near horizontal leaves. He grew the bulb at La Jolla, California, which is a cool, semiarid climate in comparison to Beaumont, Texas, except during winter. Average daily temperature in summer is 5°C lower at La Jolla, and yearly rainfall is only 25cm. A clay pot with water saucer is a poor imitation of a semiaquatic environment, and when combined with the temperature difference, one readily understands why this plant was stunted. The antenna-like projections or ovarian apical projections are not unique. I have never observed a native *C. americanum* seed pod which did not have prominent ovarian apical projections. *C. americanum* var. *robustum* is a distinctly separate cultivar which does not require a semiaquatic habitat. It is not indigenous to the Neches River, and according to T. M. Howard (personal communication), it was apparently imported to the United States long ago.

Traub (1962) again described pot-grown plants, only these were different specimens and had been collected locally in the city of Beaumont by Shirley in 1960. One bulb produced a 3 flowered scape in late September, 1961. Traub reported: "It was possible to match this up with the available meager descriptions and with Herbert's plate in **Curtis' Botanical Magazine, London** 53 pl. 2635 (1816) of *Crinum strictum*." A detailed description with numerical measurements was provided. Data included short leaves and tepal segments longer than tepal tubes. "Perianth segments longer than the tube" was reiterated in a subsequent Environmental Protection Agency publication as the means to distinguish *C. strictum* (Herbert) Traub from *C. americanum*. The legitimacy of *C. strictum* as a valid botanical name was questioned by Hannibal (1972), who classified Traub's specimen as *C. americanum* var. *texanum*.

The city of Beaumont borders the west bank of the Neches River. Directly across from the Port of Beaumont is a shallow tidal swamp approximately 500cm deep. Hundreds, perhaps thousands, of *C. americanum* grow there. Just north of this location, beyond the railroad bridge and directly across from Riverfront Park, is approximately one kilometer of gently sloping river bank where many colonies of *C. americanum* exist. I collected bulbs at both locations and cultivated them in pots with water saucers. All plants were stunted, and physical measurements similar to those reported for *C. strictum* were not uncommon during autumn. Tepal segments equal to or longer than tepal tubes is a natural phenomenon in cool weather for *C. americanum*, and this finding has no diagnostic significance in establishing a second species.

Moldenke (1962) further described Traub's specimens which had been collected by Henry in Hardin County. Moldenke observed that these plants differed from *C. strictum* in a number of particulars, and he proposed a new variety, *C. strictum* var. *traubii*. Hannibal (1972) also disputed this classification and proposed it as *C. americanum* var. *traubii*.

The only previous field observations of Neches River *Crinum* were documented by Shirley (1963, 1964). She first described the pink flowering *Crinum* of autumn. She had mailed bulbs to Traub which he identified as both *C. americanum* and *C. strictum*, and she had also sent specimens to Moldenke which he identified as *C. strictum* var. *traubii*. It must have been very confusing for her as she reported: "It appears that three different forms grow together since we have found them blooming at different times in the same places. There seems to be a slowing up between the blooming of each of these forms and this may account for their apparently not intermixing." It was her belief that blooming

time determined the species or variety of *Crinum* as follows: *C. americanum* bloomed in July and August, *C. strictum* in September, and *C. strictum* var. *traubii* in October and November. No scientific evidence was offered to substantiate this claim. Had plants been individually tagged, it would have been discovered that a single *C. americanum* bulb was capable of flowering in July, September, and November.

It is my firm assertion that only one *Crinum* species grows in the Neches River, i.e. *C. americanum*. In its native habitat, both seasonal weather factors and local environment can induce marked variations in morphology. This was not previously recognized and resulted in plant misclassification. Diverse morphologic changes are also introduced when *C. americanum* is raised in pots and other artificial settings. References which attribute *C. strictum* and *C. strictum* var. *traubii* as indigenous to East Texas should be corrected and, I believe, made synonymous with *C. americanum*. A word of caution is suggested when attempting to grow and identify plants removed from their natural environment. The degree of ecological sensitivity observed in native *C. americanum* makes any endeavor to differentiate individual varieties very suspect.

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NOTES ON SOME FRITILLARIES IN CULTIVATION

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ABSTRACT

THE cultivation of eight fritillaries is discussed and one (*Fritillaria kittaniae* Sorger) is described as a new species endemic to southwest Anatolia.

INTRODUCTION

Fritillaria L. (Liliaceae) is a genus of about 75 species distributed in temperate areas of the northern hemisphere. As many as 32 have now been recorded from Turkey and approximately 20 from neighboring Iran. The generic name is derived from Latin *fritillus*, a dice box, and presumably refers to the spotted and tessellated markings on the flowers of some members. Certain large and showy species, e.g., the Crown Imperial, *F. imperialis* L. and *F. persica* L. are now well known garden ornamentals.

For several years more than 65 different fritillaries have been grown with great success at the Royal Botanic Garden, Edinburgh. In this paper, we describe some of the lesser known taxa which, on account of their dwarf habit (all attaining less than 15cm in height) and attractive flowers, are ideal candidates for display in small pots in a cold outdoor bulb frame. We are grateful to Dr. F. Sorger, Vienna, for permission to include *Fritillaria kittaniae* Sorger, a hitherto undescribed species recently discovered in southwest Turkey by one of us (K.T.). We also acknowledge with thanks the use of material from the color slide collection at the Royal Botanic Garden, Edinburgh, with which to illustrate some of the species.

CULTIVATION

Obtaining plants is the first major hurdle to overcome. *Fritillaria kittaniae* Sorger and *F. delavayi* Franchet are not in general cultivation, but diligent searching through catalogues of specialist nurseries and seed-exchange lists would yield all other taxa from time to time.

PROPAGATION: If seeds are obtained, they should be sown, ideally in January or February, in 12-13cm diameter clay pots, using a well-drained, loam-based seed compost. Sow the seeds sparingly and cover with a few millimeters of fine grit. Water the pots from below by soaking in a bath of water, then plunge them to their rims in damp sand in a cold frame. The frame should have permanent ventilation as the glass is there to provide protection from rain and not from frost which may benefit germination. The frame lights should be removed in early May and the pots exposed to the elements if the weather is favorable. Plunged pots will be slow to dry out; when watering is required it can be done overhead through a fine rose.

The seedlings should be kept in growth for as long as possible to enable maximum bulb development. When the foliage starts to turn yellow and die down, water is withheld and the glass frame lights replaced. A fine balance must be achieved as the pots must not be

allowed to dry out completely nor remain too moist as damage to the small bulbs may occur. In September, a decision must be made either to repot the little bulbs or to retain the seedpot intact for a further year. If growth has been slow or if there are only a few bulbs in the pot, then they may remain untouched provided diluted liquid feeding is applied at fortnightly (14 day) intervals during growth in the second season. If the bulbs are large enough for repotting, again a 12-13cm diameter clay pot should be selected. The potting mixture, loam-based and well-drained, should be richer than that used for seed sowing. The small bulbs are spaced out ca. 10mm apart at the same depth as they were growing at in the seedpot. Further treatment is similar to the cultivation of mature bulbs and flowers can be expected in four to five years after sowing.

CULTIVATION OF MATURE BULBS: Fritillaries in their native habitat experience growing conditions quite dissimilar to those encountered at Edinburgh where the climate is always cool and moist with a maritime influence. To succeed we must provide protection from excess summer, autumn and winter moisture in order to simulate a Mediterranean-type climate. We achieve this to some extent by growing the plants in pots in cold frames where they have the necessary protection.

Mature bulbs are repotted annually in September. Knock them out and repot into clean containers using a fresh, well-drained, loam-based compost (at Edinburgh, a John Innes potting compost No. 3 mixture plus one-third sharp grit proved very satisfactory). Only clay pots should be used as they provide better water drainage and air circulation. When pots in bloom are displayed unplugged in full sun, there is also less likelihood of the root system overheating; however, more watering will be required than for plants grown in plastic pots. The size of the pot depends on the number of bulbs available, but to give sufficient room for root development the minimum size for one bulb should not be less than 12cm.

The bulbs are positioned in the compost at least halfway down, with the top 15mm consisting of sharp grit. This will allow watering without the fear of washing away the potting compost. It also displays the plant much better when it is in full flower. If there is an excess of loose bulb offsets at the base of mature bulbs, they can be removed and treated as one-year old seedlings, given to or exchanged with deserving friends.

After potting and plunging, the pots are watered overhead through a fine rose to moisten both pots and plunge sand. The frame lights with permanent ventilation are replaced and little more requires to be done until growth commences in late winter. With the appearance of leaves, a regular check for watering is required as an adequate water supply is essential. As soon as the leaves start expanding, liquid feeding at half the recommended rate is provided at fortnightly intervals until the foliage starts to turn yellow. Ample ventilation and air circulation should be aimed for when growth begins; the frame lights should be removed during favorable weather. Around early May they can be permanently removed and only replaced when the foliage yellows in late June. At this time all water is withheld and the bulbs baked until repotting takes place in September.

Aphids are the only pests to contend with and they are easily controlled by a commercial insecticide. *Botrytis* (grey mould) is seldom a problem and when it occurs is indicative of poor ventilation and overwatering.

Flowering occurs in March and April with *Fritillaria alburyana* among the first of our fritillaries in cultivation at Edinburgh to bloom. The flower bud pushes its way up through the grit and is already half open before it even clears the top dressing! If seed is

required from any of the species it is advisable to cross-pollinate by hand otherwise seed seldom sets.

With this method of cultivation in pots and cold frames, *Fritillaria* has not proved intractable and to prove this, a clone of *F. aurea* Schott has continued to flower and give delight at Edinburgh for more than 30 years!

TAXA

Fritillaria crassifolia Boiss. & Huet subsp. ***kurdica*** (Boiss. & Noë) Rix is a very variable subspecies found in southeast Turkey, Transcaucasia, north Iraq, west and northwest Iran. It grows from 1500 to 3500m on stony alpine steppe, open scree and limestone gorge. It can be distinguished from subsp. *hakkarensis* Rix, also from southeast Turkey and north Iraq, by its larger flowers with obtuse inner perianth segments and glaucous, not shining green, leaves. The broadly campanulate, greenish-yellow, brown tessellated flowers with their conspicuous linear nectaries may not be considered particularly showy but they have a certain appeal of their own and, together with the glaucous leaves, make an attractive picture (Figure 1).

***Fritillaria* sp.** (Figure 2). Bulb ca. 1.5cm in diameter. Stem 5–10cm, smooth. Leaves 5–7, glaucous; lowest opposite, lanceolate, 5–7 x 0.7–2.5cm. Flowers large, solitary, nodding, very broadly campanulate, with a greyish-glaucous bloom and tessellated dark reddish-purple outside, greenish-yellow with blackish-purple tessellations inside; perianth segments oblong-ovate, 3–4.5cm long, obtuse, incurved at apex. outer 1.5–2cm broad, inner ca. 2–2.5cm broad. Nectaries ovate-lanceolate, 4–6 x 1–2mm broad, at angle of bell 12–15mm above base of perianth, deeply impressed filaments 12–15mm long, smooth or minutely papillose; anthers 8–10mm. Style c. 25mm long, 3-fid; branches 4–6mm long, smooth. *Flowering in cultivation March.*

The above description is based on plants cultivated at the Royal Botanic Garden, Edinburgh under Accession number 772060 as aff. *F. straussii* Bornm. They were grown from bulbs received by Peter Davis from Erich Pasche Jr., Langeberg, West Germany in late August 1977. The bulbs were collected in northeast Turkey in the vilayet of Erzurum, together with several others belonging to the genera *Crocus*, *Gagea*, *Ornithogalum* and *Scilla*. 'Typical' *F. latifolia* was also growing in the same locality, near the top of the well-botanized Kop Dağı pass, in melting snow at ca. 2300m.

We thought our plants had a close resemblance to *F. latifolia* Willd. but differs by their glaucous leaves with a greyish-glaucous bloom, larger nectaries and much longer style; a photograph of the latter in its native state is provided that the differences between the two taxa may be more apparent.

Fritillaria latifolia Willd. (Syn: *F. nobilis* Baker in Bot. Mag. 122:t.7500, 1896). (Figure 3).

This species which occurs in northeast Turkey, Caucasus and Iran has shining green, not glaucous, leaves. The nectaries are never linear but ovate to lanceolate. It is related to *F. aurea* Schott, a beautiful yellow-flowered Turkish endemic.

Fritillaria aurea was originally described by Schott in Öst. Bot. Wochenbl. 4:137 (1854) from specimens collected in the Cilician Taurus in 1836 by Carl Georg Theodor Kotschy. The latter was an Austrian botanical explorer who travelled widely in the Orient from 1835 to 1843. Evidence of his assiduous collecting can be seen in his number of specimens

Figure 1. *Fritillaria crassifolia* subsp. *turdica* in cultivation. All photos courtesy Royal Botanic Garden, Edinburgh color slide collection unless otherwise cited.



Figure 2. *Fritillaria* sp. in cultivation.



Figure 4. *Fritillaria aurea* in the wild. Photo by Adam Sainson.



Figure 6. *Fritillaria albuargana* in cultivation.

Figure 3. *Fritillaria latifolia* in the wild.



Figure 5. *Fritillaria kittanae* in cultivation. Photo by Dr. F. Sorger.



Figure 7 & 8. *Fritillaria minuta* in cultivation.

which total more than 300,000! *F. aurea* has comparatively large, nodding flowers. The lightly tessellated perianth, varying from all shades of clear to golden yellow and orange bronze, makes it a most charming little Fritillary well-suited to cultivation and increasing rapidly by its many bulblets.

The accompanying photograph (Figure 4) was taken in late May by Adam Stainton in Turkey, in the vilayet of Sivas. He discovered it growing, quite profusely, on dry rocky limestone slopes at ca. 2000m, between Pinarbaşı and Gürün. It is native to central and south Turkey; at 1800m, under *Juniperus* forest usually on limestone, and at the higher altitudes of 2500-3000m, growing through snow.

***Fritillaria kittaniae* Sorger, sp. nova** (Figure 5).

Affinis *F. acmopetalae* Boiss. subsp. *wendelboi* Rix (species montium Taurorum centralium) sed humiliore, floribus minoribus bicoloribus (purpureis et luteis), segmentis interioribus perianthii obtusis haud recurvis, stylo brevior, grosse papilloso differt.

Herba perennis. Bulbus ad 1cm diametro; tunicae tenues, papyraceae; bulbilli pauci, 1-2. Caulis 6-11cm altus, laevis, glaber. Folia 4(-5), omnia alterna, elliptico-ovata ad anguste elliptico-lanceolata, infima 2-4 x 0.3-0.5(-1)cm, subacuta, glabra, glauca. Flores solitarii, nutantes. Perianthium campanulatum haud tessellatum; segmenta exteriora leviter recurvata, elliptico-ovata ad anguste obovata, 15(-18) x 4-6mm, extus intusque pallide purpurea fascia lata flavovirenti, apice ciliato-caespitoso; segmenta interiora elliptico-obovata, exteriora \pm aequantia, ad 5mm lata, non recurvata, flava fascia pallide flavovirenti, obtusa. Nectaria ad angulum perianthii campanulati inserta, elliptica, parva. Filamenta 8-11mm longa, expansa, papillosa; antherae 5mm longae, luteae. Stylus ad 7mm longus, 0.8mm diametro, trifidus; brachiis 4-5mm longis, crassis, papillosis. Capsula ignota.

Perennial with bulb to 1cm in diameter; scales few, tightly imbricate; tunics thin, papery; bulblets few, 1-2. Stem erect, 6-11cm tall, smooth, glabrous. Leaves 4(-5), all alternate, elliptic-ovate to narrowly elliptic-lanceolate; lowest 2-4 x 0.3-0.5(-1)cm, subacute, glabrous, glaucous. Flowers solitary, nodding. Perianth campanulate, completely untessellated; outer segments slightly recurved, elliptic-ovate to narrowly obovate, 15(-18) x 4-6mm, pale purple outside and inside with broad yellowish-green fascia, apex ciliate-tufted; inner segments elliptic-obovate, \pm equalling outer segments, to 5mm broad, not recurved, clear yellow with pale yellowish-green fascia, obtuse. Nectaries at angle of bell, elliptic, small. Filaments 8-11mm long, expanded, papillose; anthers 5mm long, yellow. Style to 7mm long, 0.8mm in diameter, 3-fid for 4-5mm; branches thick, papillose. Capsule unknown. Flowering April; in cultivation May. Limestone rock in *Cedrus libani* forest, ca. 1500m.

Type: Turkey C2 Antalya: south of Sinekçibeli geçidi, on limestone rock in *Cedrus libani* forest, 1500m, 23 April 1984, F. Sorger & Kit Tan 84-18-8 (holo. Hb. F. Sorger; iso. E, RSA).

Endemic to southwest Anatolia (Lycia). East Mediterranean element. Known only from the type and material cultivated at Vienna (flowering 3 May 1986; Sorger 86-1-1). The nearest affinity for this dainty little *Fritillaria* is with *F. acmopetala* Boiss. subsp. *wendelboi* Rix, known only from the central Taurus in south Anatolia. The latter is a much taller plant with larger greenish-brown flowers, the inner perianth segments of which are recurved and apiculate, the style longer, slender and non-papillose; the nectaries ovate-lanceolate and blackish. It also has a similar habitat, growing well in *Cedrus* forest at altitudes from 1600-2020m.

The above description was based on plants of wild origin; bulbs were also collected, and kept in cultivation at Vienna where they flowered beautifully in the spring of 1986.

The species is named in honor of Dr Kit Tan, my valued and long-term collaborator, a co-editor of the *Flora of Turkey* and currently research associate on *Flora Hellenica*—F. Sorger.

Fritillaria alburyana Rix is endemic to east Turkey and taxonomically a very distinct species without close allies. Its clear green leaves and lightly tessellated, pale rose-pink flowers form a beautiful contrast against the bare, dark soil and melting snow on the Palandöken Dağı where one of us (K.T.) had the fortune of seeing it in full flower on an open scree slope during July 1981. It was first discovered by M. J. Cheese together with S. Albury and J.M. Watson in June 1966 at 2900m on the Çakmak Dağı, a basalt massif approximately 80km south-southeast of Erzurum. Since then, it has been recorded in several localities in eastern Turkey, notably in the vilayets of Erzurum, Bingöl and Van; thus it is not as rare as had previously been supposed.

Although regarded as 'disappointing' and difficult to flower well in cultivation, perhaps because the winters in eastern Turkey are far more severe than ours (in Erzurum, temperatures may fall to -40 degrees c. at night), the accompanying photograph (Figure 6) shows *F. alburyana* thriving quite well at Edinburgh where its spreading, cup-shaped flowers are much admired.

Fritillaria minuta Boiss. & Noë. Bulb to 1.8cm in diameter, with few bulblets. Stem 10-12cm tall, finely papillose to almost smooth. Leaves alternate, 5-6, glossy green beneath, dull green above; lowest narrowly ovate-elliptic, 7-9 x 1.5-2cm, uppermost lanceolate, to 6.5cm long. Flowers solitary, \pm horizontal, later half-nodding. Perianth spreading campanulate, not tessellated, outside greyish-mauve over yellow, veined darker purple, dull yellow and fimbriate-papillose at apex, inside dull yellow; segments ovate, 20-22mm long, subacute to slightly apiculate; outer 8-9mm broad, inner ca. 8mm broad. Nectaries elliptic-circular, ca. 1.5mm, glistening green, 1-1.5mm above base of perianth. Filaments ca. 10mm long, slender, papillose; anthers yellow. Style ca. 9mm long, 3-fid, almost smooth; branches to 4mm long, recurved at maturity. Capsule unwinged. *Flowering June; in cultivation late March.*

F. minuta (Syn: *F. carduchorum* Rix in Notes R.B.G. Edinb. 31:125, 1971) native to east Turkey and northwest Iran, has been described as characterized by a small, narrowly campanulate perianth with lanceolate segments, lanceolate, 2-4mm (not ca. 1.5 x 1.5mm) long nectaries and a much shorter, 4-7mm style. The few herbarium specimens of *F. minuta* we have been able to examine, verify this. However, barring the morphological dissimilarities mentioned, our description, which was drawn up from the originally distributed material (Sonderhausen 808), fits typical *F. minuta* in all other respects.

The plants on which our description is based were collected on 6 June 1982 by Ole Sonderhausen in southeast Turkey in the vilayet of Hakkari, 8-10km west of Semdinli, growing at ca. 1850m in deciduous *Quercus* forest. The accompanying photographs (Figures 7 & 8) are of the same plants which flowered again in cultivation at Edinburgh (Accession number 821946) in late March.

***Fritillaria delavayi* Franchet.**

Bulb ovoid to globose, to 2cm in diameter; scales few, 3-4; tunics thin, papery. Stem flexuous, 10-15cm tall, thick. Leaves 4-7, subfleshy, elliptic to ovate-lanceolate, 5-6 x

2-3cm, dull greyish-green tinged purplish-brown, obtuse; lower alternate, uppermost subopposite. Flowers large, solitary, half-nodding, campanulate. Perianth segments fleshy, 4-5cm long, dingy purplish- to greyish-brown, faintly tessellated or untessellated outside, paler colored and brown-tessellated on inside. Style 3-fid. Capsule developing within persistent perianth.

The above description of a curious fritillary from China is based on living material seen in the wild. How this came about is as follows.

During May and June 1987, one of us (R. McB.) participated in a six week expedition to Yunnan. On one occasion, while botanizing high on the eastern flanks of the Lichiang range in northwest Yunnan, he nearly trod on a strange little *Fritillaria* miraculously growing in, and well-camouflaged against, the coarse angular grey limestone scree. This was *F. delavayi* Franchet, a species first described in 1898 by Adrien René Franchet from material collected by the missionary Abbé Pierre Jean Delavay who botanized extensively in Yunnan from 1884 to 1895. The Abbé discovered several plants growing at the base of the Lichiang glacier at ca. 3800m. The bulbs of this fritillary lie deep—10cm or more below the surface of broken, unstable rock and in hardly any soil. The species is believed to be endemic to the mountains of southwest Sichuan and northwest Yunnan, growing at an altitudinal range of 3000 to 4875m. The flowers have been reported by various other collectors as strongly fragrant. As far as we are aware, the plant has never been brought into cultivation although eagerly sought after for some years.

As collecting bulbs of this and other rare species from China is prohibited by the Chinese authorities, R. McB. had to be content with taking numerous photographs of the fritillary in its native habitat, four of which are reproduced here (Figures 9-12). We have, however, developed close ties with several Chinese botanists attached to the Royal Botanic Garden, Edinburgh on various exchange programmes and it is to be hoped that very soon, this unusual *Fritillaria* will be in cultivation and made available to *Fritillaria* enthusiasts the world over!



Figure 9. *Fritillaria* scree, above Xiang Jing-Yuan, Yunnan. Photo by Ron McBeath.



Figures 10. *Fritillaria delavayi* in the wild. Photo by Ron McBeath.



Figure 11. *Fritillaria delavayi* in the wild. Photo by Ron McBeath.

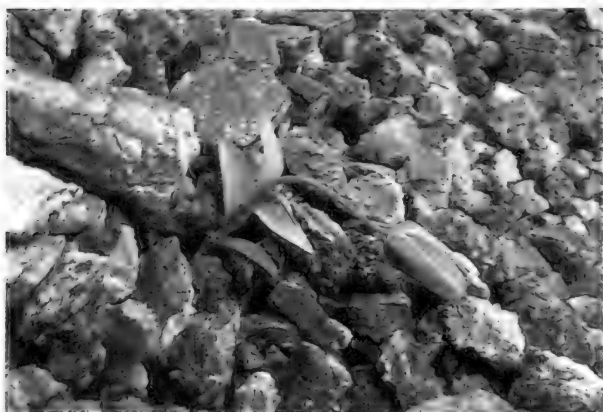


Figure 12. *Fritillaria delavayi* in the wild. Photo by Ron McBeath.

A REVIEW OF *STENOMESSON*

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ONE of the more striking patterns within Amaryllidaceae subfamily Pancratiodeae is the parallel evolution that has occurred within different tribes of the subfamily. That a large, white or yellow, fragrant *Pancratium*-like flower—adapted largely for hawkmoth pollination—represents the ancestral floral morphology for the subfamily seems a reasonable hypothesis (Meerow, 1985, 1986, 1987). Within each natural group within the subfamily, one or several genera can be found with a *Pancratium*-like flower. I have referred to the five genera with this type of flower morphology, i.e. *Eucharis* Planch. & Lind., *Hymenocallis* Salisb., *Pancratium* L., *Pamianthe* Stapf, and *Paramongaia* Velarde as “the pancratioid base” (Meerow, 1985) to reflect the putative antiquity of this flower type within the family. In tribe Stenomesseseae, there are two such genera, *Pamianthe* and *Paramongaia*. Within each of these tribes are also one to several genera characterized by smaller, green or brightly colored flowers which are found at higher elevations than the genera with typical pancratioid morphology. The brightly colored, often tubular or urceolate flowers of these high elevation genera suggest that they are adapted for bird pollination, though confirming observations are few. Just as *Urceolina* Reichb. represents the hummingbird-adapted divergence from *Eucharis* (Meerow, 1986), *Stenomesson* appears to occupy a similar phylogenetic position in relation to *Pamianthe* and *Paramongaia*.

The genus *Stenomesson* Herbert is the largest and most variable group of pancratioid Amaryllidaceae found in the Central Andes, the area of greatest diversity for this subfamily. The genus consists of several dozen species, but patterns of infraspecific variation have resulted in a multiplicity of names, many of which remain to be sorted out properly. The rarity of the plants in nature, and the absence of type specimens for a number of these names, are the greatest obstacles to a definitive taxonomy of the genus. The diversity of vegetative and floral form in *Stenomesson* presents a great many unsolved questions to the plant biologist interested in the pathways of evolution.

Traub (1963) recognized four subgenera in *Stenomesson*; i.e., *Stenomesson*, *Callithauma* (Herbert) Traub, *Carpodetes* (Herbert) Traub, and *Clinanthus* (Herbert) Traub. Ravenna (1974) added two more: *Clitanthes* (Herbert) Ravenna, and *Fugituba* Ravenna. Six subgenera in a group of perhaps forty species seems overstated, and we will return to these subgeneric taxa shortly. As is evident from the parenthetical authorship of these names, Dean William Herbert was inordinately fond of establishing genera!

Species of *Stenomesson* are denizens of the seasonally dry western Andean slopes, usually above 2000m elevation. A number of these species can be considered true xerophytes, and may be found in the company of various cacti and xerophytic Bromeliaceae (Figure 1). A cluster of species has also become established in the coastal “loma” formations of Peru, those undulating sandhills which rise up to less than 1000m, receive little direct precipitation, but remain cool and seasonally moist due to the influence of the Humboldt current. Some of these loma species may in fact flower only once every several years, when conditions (often coinciding with a particularly strong “El

Niño" event) are best for successful seed production. To date, only three to four species of the genus have been reported or described outside of Peru.

Two major morphological groups can be recognized within *Stenomeson* on the basis of leaf morphology. Both groups cross the boundaries of several of the erstwhile subgenera recognized in the genus. The first group has taxa with sessile, linear to lorate leaves which lack any differentiation into petiole and blade. The leaves may or may not be glaucous, are often channelled or keeled, but a distinct midrib is not conspicuous on the upper surface of the leaf. The leaves emerge unrolled from the bulb. A few representative species of this group are *S. variegatum* (R. & P.) Macbr. (Figure 2), *S. incarnatum* (H. B. K.) Baker (Figures 3-6), and *S. mirabile* Ravenna (Fig. 8). The second, and apparently larger, group of species has distinctly petiolate leaves, though the petiole is often short. The leaf blade of this latter group ranges from very narrowly lanceolate to elliptic, and resembles that of some species of *Phaedranassa* Herbert. The midrib is conspicuous on the upper surface, regardless of the blade's width. The leaves of this group emerge from the bulb revolute at the margins. I suspect that this dichotomy in foliar morphology divides the genus along more natural lines than does the profusion of subgenera previously delimited. The petiolate-leaved group may even be the direct ancestors of *Eucrosia* Ker-Gawler, *Phaedranassa*, and *Rauhia* Traub (Meerow, 1987), three closely-related genera that form a distinct subgroup within tribe Stenomesseae. *Stenomeson miniatum* (Herbert) Ravenna (Figure 10) and *S. aurantiacum* (H. B. K.) Herbert are among this latter assemblage of species.

The sessile-leaved *Stenomeson* species embrace some of the more stunning flowers found among Andean Amaryllidaceae. The best known species in this group comprise subgenus *Fugituba*, many of which were originally described within *Coburgia* Sweet. These species, which I informally call the "variegatum complex," have been reported from Ecuador to Bolivia; widespread, but nowhere abundant.

Stenomeson variegatum (Figure 2), first described by Ruiz and Pavon (1802) as *Pancratium variegatum*, has had a controversial nomenclatural history in tandem with the closely related *S. incarnatum*. In a broad sense, these two species are arguably the most over-named taxa in the genus. Until I flowered material of *S. variegatum*, I, too, was inclined to lump these two robust growers as a single species. Ruiz and Pavon described *P. variegatum* from material they encountered in cultivation in Lima, and were unsure of the nativity of the plant. *Stenomeson variegatum* is indigenous to southern Peru and contiguous northern Bolivia. It appears to be absent from the northern half of Peru, while *S. incarnatum* sensu lato, has been collected from southern Peru, albeit rarely. *Stenomeson variegatum* matures into a large bulb some 7cm in diameter with a long neck or pseudostem. The leaves are slightly succulent, channelled, and lightly glaucous. Scapes carry 5-10 flowers, with 7-8 the usual number. The 8-10cm long flowers are mostly yellow, with a variable suffusion of rose along the tube. The apices of the short limb segments are green spotted, as are the teeth of the staminal cup. The tepals terminate in a short, white apiculum. The cup itself is approximately 1cm long (to the apex of the teeth), and it is this character which separates *S. variegatum* from *S. incarnatum* beyond the vagaries of mere flower color (see discussion of the latter species below). *Stenomeson fulvum* (Herbert) Ravenna and *S. luteoviride* Baker, the latter supposedly collected in Ecuador with no further locality data, may not be distinct from this species. Baker (1880), in a great example of taxonomic puffery, declared a number of erstwhile species in the variegatum complex to be "mere varieties" of *S. variegatum*, even as he described yet another as *S. luteoviride*! *Stenomeson imasumac* Vargas (1969) does, at first reading

Figure 1. Typical Andean habitat of many *Stenomesson* species in Peru. All photos by Alan Meerow unless otherwise credited.

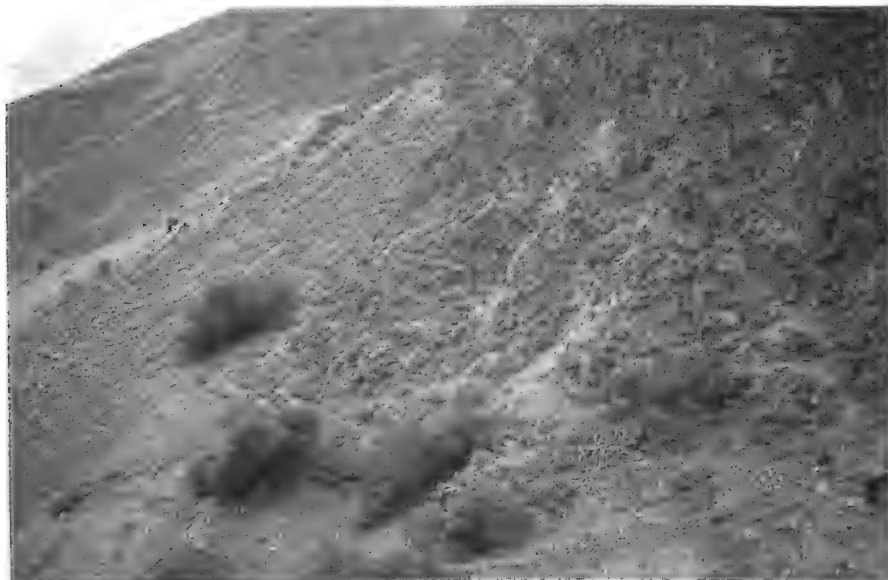


Figure 2. *Stenomesson variegatum*.



Figure 3. *Stenomesson incarnatum*. Photo courtesy of Timothy Plowman.

Figure 4. *Stenomesson incarnatum*, pink form.



Figure 5. *Stenomesson incarnatum*, robust pink form with semi-erect flowers. Photo courtesy of Michael Dillon.

of the description, appear to be synonymous with *S. variegatum* as suggested by Ravenna (1974). However, clonotypic material of this species which I have in cultivation, but have yet to flower, consistently enters an annual, leafless, dormant period, while plants of *S. variegatum* are content to bear foliage throughout the year. The flowers of *S. imasumac* supposedly have a less declinate habit than those of *S. variegatum*.

Stenomesson incarnatum (Figures 3-5) has been collected in both Ecuador and Peru, though the original collections by von Humboldt and Bonpland were reportedly Ecuadorean. The species is not common in the former country. The most recent Ecuadorean material that I have seen of *S. incarnatum* dates to the 1940's. At present, I am inclined to consider *S. splendens* (Herbert) Ravenna and *S. trichromum* (De la Llave & Lex.) Ravenna as synonyms of *S. incarnatum*. Throughout its range, *S. incarnatum* varies in flower number, habit, color, and size (Figures 3-5). Ecuadorean collections tend to be a rich, brick-red color (Figure 3), while Peruvian material ranges from red-orange to salmon to pink (Figures 4-5). The staminal cup of *S. incarnatum* is greatly reduced in comparison to that of *S. variegatum*, and does not exceed 5mm in length. Flower number is considerably variable in this species. A particularly robust form with over a dozen flowers was described by Andre (1877) as *Coburgia trichroma* var. *speciosa*. At present, such a broad concept of *S. incarnatum* may include more than one species, but I do not see how such judgements can be made until sufficient populations of *S. incarnatum* sensu lato, are studied in detail.

At least one species belonging to the *variegatum* complex has adapted to the low elevations of the lomas. Having examined some excellent specimens of this plant collected by Paul C. Hutchison during his association with University of California, Berkeley Botanical Garden, the plant resembles a miniature *S. incarnatum* in every aspect. Ravenna (1978) considers this loma plant to be the true *S. coccineum* (R. & P.) Herbert.

The Department of Cajamarca in northern Peru is a haven for representatives of subgenus *Fugituba*. At present I am studying a narrow-leaved representative of this group which I have flowered once (Figure 7). It does not fit any extant description. In coloration pattern, the perianth slightly resembles that of *Eustephia coccinea* or some species of *Phaedranassa*.

Subgenus *Callithauma* is delimited by essentially two characters. The flowers of this subgenus are completely or partially green, and the free portion of the staminal filaments are inserted below the rim of the staminal cup. *Stenomesson mirabile* Ravenna (Figure 8) is representative. The relationship to subgenus *Fugituba* is evident in both the overall morphology of the flower and the robust, glaucous leaves. *Stenomesson viridiflorum* (R. & P.) Benth. & Hook., as illustrated in Curtis' Botanical Magazine (Herbert, 1841), looks very much like *S. mirabile*, but is entirely green. However, *Stenomesson elwesii* (Baker) Macbr. (Figure 9), which was placed in this group by Baker (1878) as *Callithauma viridiflora* var. *elwesii*, differs by its perianth shape, more typical staminal cup, petaloid free filaments, and pollen tetrads (Meerow et al., 1986). It is the only species of Amaryllidaceae so far known that releases its pollen in aggregates of four grains. From the description, *S. caracense* Ravenna (1974) seems a likely candidate for synonymy with *S. elwesii*. The relationship of *S. elwesii* to *S. mirabile* and *S. viridiflorum* is doubtful.

Another group of sessile-leaved *Stenomesson* have adapted to the frosty limits of vegetation in the Andes by retaining the scape (and ovary) entirely inside the bulb until the capsule is nearly ripe. These single-flowered species have been collected above 4000m in southern Peru. The superficial resemblance to a crocus no doubt inspired Pax (1889) to designate the genus *Crocopsis* for this group, but Traub (1963) reduced *Crocopsis fulgens* to synonymy with *Stenomesson humile* (Herbert) Baker. Additional synonymy is

listed by Ravenna (1971). As evidence of the rampant parallelisms even among widely unrelated Amaryllidaceae, the crocus-like habit has evolved among some species of *Zephyranthes* Herbert as well [subgenus *Haylockia* (Herbert) Traub]. Ravenna (1974) described a new species of this group of *Stenomesson* from Chile, and also established subgenus *Clitanthes* to accommodate them. Ravenna did not, however, provide abundant characteristics by which to separate the Chilean plant from *S. humile*. Examination of specimens of *S. humile* from Peru does reveal considerable variation in flower size and coloration, and perhaps two species are represented within the complex in Peru alone.

The petiole-leaved *Stenomesson* species are less well-known but for a few ubiquitous species. Foremost among them is *Stenomesson miniatum* (Herbert) Ravenna (Figure 10), which for many years masqueraded as an *Urceolina* species (Ravenna, 1978). This species occurs throughout the southern Peruvian Andes above 2500m. *Stenomesson aurantiacum* (H. B. K.) Herbert (see *Herbertia* 40: 9 for an illustration) is as ubiquitous in the high western Andes of Ecuador, southwestern Colombia, and northwestern Peru. Though the leaf blade of the latter species is very narrowly lanceolate, a short petiole is apparent. *Stenomesson pearcei* is a yellow-flowered species from Cuzco department in Peru. Other species include *S. campanulatum* Meerow (Figure 11) and *S. latifolium* Herbert (Figure 12). Though a number of the petiole-leaved stenomessons are represented in my research collections, only *S. miniatum* flowers reliably.

CULTURE

Stenomessons are by and large cool growers. Even the low elevation species are adapted to mild temperatures, since the coastal areas of Peru rarely receive temperatures in excess of 80°F. Consequently, maintaining a research collection of these plants in Florida has not been easy. I keep all stenomessons in close proximity to the evaporative cooling pads in the greenhouse. Though evaporative cooling does not function very efficiently during Florida's humid summer, day temperatures adjacent to the pads remain not far above 80°F, even on the hottest days. I have begun to experiment with placing dormant bulbs in coolers at 40°F, in the hopes that species reticent to flower can be stimulated to do so. I am particularly hopeful that the alpine *S. humile* will react favorably to this treatment. Under my conditions, *S. variegatum*, *S. incarnatum*, and *S. elwesii* flower annually. One clone of *S. incarnatum* has flowered twice annually. As mentioned, most of the petiole-leaved species, with the exception of *S. miniatum*, while luxurious in foliage, have yet to flower. The bulbs are potted in standard peat-based media with the addition of 1 part each by volume of perlite and coarse, feldspar sand. Most of the *variegatum* group do not appear to demand an enforced dormant period to flower under my conditions. The bulbs are not disturbed in their pots until breakdown of the medium begins to effect growth, since established bulbs seem to flower most readily. Bulbs of the *variegatum* group are potted shallowly, with the shoulders of the bulb and long pseudostem left exposed. The petiole-leaved species are placed a few inches below the soil line in the pot.

Stenomessons have not been bothered by many pests or diseases in the greenhouse. Spider mites will sometimes infest leaves of the *variegatum* group, while mealy bugs turn up from time to time on foliage of both this group and the petiole-leaved species. Mosaic virus occurs in some of my collections, an unfortunate accompaniment to long-term cultivation. Fortunately, I have not experienced any losses due to systemic bacterial infection, a problem that has plagued my collection of *Eucharis*.

Stenomessons appear to be self-incompatible, and I have also encountered putative sibling sterility (see Koopowitz, 1986) in *S. variegatum*. Part of the problem may be that

Figure 6. *Stenomesson incarnatum*, salmon-orange form.



Figure 7. *Stenomesson* species, possibly undescribed.



Figure 8. *Stenomesson mirabile*.



Figure 9. *Stenomesson elwesii*.



Figure 11. *Stenomesson campanulatum*.

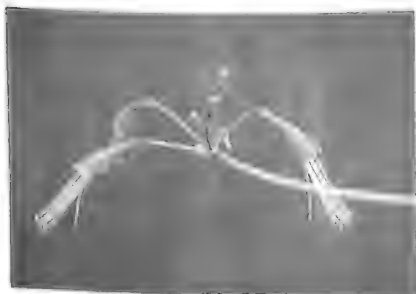


Figure 12. *Stenomesson latifolium*.



the window of stigma receptivity is of extremely short duration in these plants. Some experiments are planned in the future with pollen application to the cut surface of decapitated styles.

CONSERVATION

Stenomesson species may not be as immediately endangered by habitat destruction as species of *Eucharis* and *Urceolina* which inhabit low and middle elevation rain forests. In some cases, the steep and rocky slopes wherein a number of *Stenomesson* species occur may be safe for some time from the pressures of burgeoning populations in South America. Nonetheless, montane agriculturists are exceptionally versatile at exploiting arable lands, and areas of the seasonally dry, western Andean slopes have been terraced and placed under cultivation since Pre-colombian times. Consequently, rare plants of limited distribution and small population size, a status for which many *Stenomesson* species qualify, can easily be decimated by local, small-scale disturbance. I agree vociferously with Koopowitz (1986) that the onus of conservation must fall upon those of us involved botanically and horticulturally with the Amaryllidaceae.

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Figure 10. *Stenomesson miniatum*.

A SOUTH AFRICAN *CRINUM* SAFARI

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HAVING been blessed with a small sum of unexpected capital in late 1986, I hastily organized a safari to South Africa and South West Africa. My mission had a singular purpose: to observe and photograph indigenous *Crinum* in the wild. Fortunately, tourism is a major industry in the region. The South African Consulate in Houston provided me with a generous supply of detailed maps and listings of hotel/motel accommodations when I applied for a visa. Armed with a copy of Verdoorn's "The Genus *Crinum* in Southern Africa," I plotted reported locations of *Crinum* sightings on the maps and then charted a tentative course. My plan was to rent a car, and frankly, see what I could find. Several APLS members kindly shared names and addresses of potential contacts who might possibly assist me in locating native *Crinum*. Otherwise, I would be a complete stranger in a distant land.

The expedition departed on January 21, 1987, which corresponded to midsummer and was not an ideal time to observe flowering plants. I drove 11,500km searching for *Crinum* during my 23 days in the field. My rented vehicle was a 1.4 liter minicar with an automatic transmission, a standard sized automobile in South Africa. Major highways were paved and in good condition, but secondary roads outside metropolitan areas were usually unpaved and sometimes pretty rough.

The first day was spent in Johannesburg, which afforded me a challenging opportunity to learn how to drive on the wrong side of the street while steering from the wrong side of the car. My initial personal contacts were exceedingly helpful and were a prelude to future encounters during the remainder of the journey. I must state that if the persons I met were representative of the nation as a whole, South Africans were clearly the most hospitable people in the world. On numerous occasions, individuals accommodated me, a total stranger, to such a degree beyond the requisites of social etiquette, that I actually felt embarrassed.

Crinum are protected species in South Africa, and it is against the law to dig native bulbs or collect seeds without a permit. I visited several local nurseries to inquire if they carried *Crinum* for sale, and I received the usual blank stare followed by a "what are those" response which I normally encounter in my country. I soon learned that most commercial nurseries dealt in proteas, orchids and imported plants, and only at one of the rare indigenous nurseries could I expect to purchase *Crinum*. One such nursery existed near Johannesburg at Witkoppen, and here there were four species available, including a large naturalized clump of *C. moorei* which was blooming. To the west near Roodepoort, the Witwatersrand Botanical Garden offered *C. buphanoides* bulbs for sale.

On the next day I drove to the Botanical Research Institute in Pretoria. Personnel at the nursery were most gracious, and I was given a personal tour of the facility. My education in South African *Crinum* began with a shock. Most of the bulbs maintained in the greenhouses were cultivated in pots of sand; very dry sand to say the least. I could not imagine raising *Crinum* in anything but moist clay soil! Many regions of South Africa nor-

mally experience seasonal dry periods which can be quite prolonged, and aridity is a common ecological condition for indigenous *Crinum*. No plants in the greenhouse collection were flowering. Only one clump of *C. bulbispermum* was in bloom on the grounds; it was difficult to be absolutely certain of the identity because the scapes had appeared in the absence of leaves. This latter phenomenon puzzled me until we later found two other clumps of *Crinum*, one completely defoliated and the other severely infected by the amaryllis worm. This pest initially invades the underside of a leaf, and then it bores down the center of the leaf shaft to the top of the bulb where the feast begins. Within a week, a single worm can destroy the entire leaf structure of a large plant. Fortunately, bulbs are seldom killed as the worm usually confines its demolition to the neck and upper bulb. Spraying with insecticide once a week is a necessity.

The journey commenced with a loop through the north and east portions of the Transvaal. Much to my disappointment, all the land was heavily fenced, and the dots I had made on the maps of *Crinum* sightings were indeed just dots. It was frustrating, and I was left with no alternative other than to periodically stop and request assistance from local inhabitants. My first experience with indigenous *Crinum* occurred near Potgietersrus, where an Afrikaner farmer kindly directed his son to chauffeur me through 400 hectares of his ranch which had never seen the plow. For a *Crinum* enthusiast, it was heaven. The land was relatively flat, grassy, and populated by a scattering of scrub bushes and small trees. A sizeable portion housed a large, very shallow vlei (pond) during the wet season, but it was nearly dry and overgrown with grass which made it difficult to determine its boundaries. Located peripheral to the vlei were many small clumps of *C. lugardiae*, characterized by short, narrow, channeled, somewhat wavy leaves. None were in flower, but a good number had clusters of small seeds lying on the ground nearby. More removed from the vlei territory was *C. buphanoides*, easily recognized by its distichous leaf arrangement (Figure 1). It occurred mostly as random solitary plants with an occasional loosely congregated group of two or three observed. None were in flower, nor were there any plants with offsets. Also present, but not in flower, was *Ammocharis coranica*. It was early evening when we returned to the farmhouse, and along the way we spotted three different species of antelope.

Near Haenertsburg I visited a genuine indigenous nursery located in a remote hilly setting, where *C. macowanii* was native (Figure 2). This variety had long green leaves with virtually no undulations. I was generously supplied with seeds. Fortunately for me, the proprietress gave me explicit directions to the late Gordon McNeil's estate near Ofcolaco, because without them I would never have attempted to travel the unmaintained, travel at your own risk, rural roads. It was certainly worth the effort. The estate was nestled in a narrow valley surrounded by steep rocky mountains (Figure 3). The large, primitive, grass-thatched home was encircled by approximately five hectares of rock-terraced gardens, where thousands of *Clivia* were cultivated. Sprinklings of *Crinum*, *Cyrtanthus*, *Agapanthus*, and other plants were also to be seen. Monkeys were swinging in the trees, and baboons chattered in the bushes. Mrs. McNeil took me on a hike through the neighboring 400 hectares of virgin tropical rain forest. In his garden was a *Crinum* in bloom which I did not recognize as belonging to the South African varieties, and I mistakenly presumed it to be a hybrid. Subsequent to my return, I learned that it was *C. fimbriatulum* from Angola; see page 248 in Hannibal's (1979) "Garden *Crinums*."

The first indigenous *Crinum* in bloom in the wild which I discovered was in Kruger National Park. *C. delagoense* was readily visible from the roadside at two locations near the Paul Kruger Gate. It was quite dry, and the flower umbels were badly drooping in the

Figure 1. *Crinum huphanoides*. Pasture near Poigietersrus, Transvaal. January 23, 1987.
All photos by the author.



Figure 2. *Crinum macowanii*. Adjacent to stream 33km south of Orijwarongo, South West Africa. February 7, 1987.



Figure 3. Home of the late APLS member Gordon McNeil. Near Ofcolaco, Transvaal.
January 24, 1987.



Figure 8. *Crinum lugardiae*. Low area 87km west of Witvlei, South West Africa.
February 11, 1987.

Figure 4. *Brunsvigia radulosa*. Roadside south of Nelspruit near Swaziland, Transvaal. January 26, 1987.



Figure 5. *Brunsvigia natalensis*. Hillside on outskirts of Harrismith, Natal. January 30, 1987.



Figure 6. *Crinum lineare*. Walmer District, Port Elizabeth, Cape Province, February 2, 1987.



Figure 7. *Crinum variable*. Dry stream bed 9.7km south of Nieuwoudtville, Cape Province. February 5, 1987.

afternoon heat. All plants had long, wide, stiff channeled leaves. A number bore scapes with large reddish fruiting bodies approaching the size of baseballs. The seed pods were thick and fibrous, and they did not have apical projections. The smaller pods were laden with smooth surfaced seeds, but the baseball sized ones were barren or contained only a single small seed or two.

An indigenous nursery near Lydenburg raised *C. moorei*. The manager eagerly showed me a large stand of blooming *Brunsvigia radulosa* which was absolutely spectacular. The nearby Lowveld Botanic Gardens at Nelspruit listed two indigenous species on record, *C. foetidum* and *C. macowanii*. It had been extremely dry. Leaves were tattered, and the plants were obviously in a state of dormancy. I never identified any plants of *C. foetidum* for certain.

I next attempted to take a shortcut through Swaziland to reach Zululand in East Natal, but I encountered a stretch of treacherous narrow mountain road under construction. This caused me to arrive at the border gate after it had closed. A day was lost in the process, and the only reward was a beautiful *B. radulosa* in bloom which I spied along the roadside (Figure 4). Driving the dirt roads of rural Zululand was similar to being in a dust bowl. It was far too dry and obviously not the proper time to be flower hunting. One exception occurred in the Ndumu Game Reserve adjacent to the border with Mozambique, where there were two *Crinum* growing in thick clay along the edge of a small water filled vlei. Rhinoceros tracks dotted the shallows. The plants had light bluish green, somewhat arching, channeled leaves. Each had recently borne a scape of five flowers and was going to seed. Pedicels were very short to nonexistent. A tentative identification of *C. paludosum* was entertained.

The Botanic Gardens in Durban had neatly kept plantings of *C. moorei*, *C. macowanii* and *C. pedunculatum*. An employee of the Parks Department took me to a place called the "blue lagoon" where there were multiple clumps of a huge asiatic type *Crinum*. Judging from the exposed portions of the bulbs, I estimated each would easily fill a 10 liter pail. Umbels had approximately 15 white stenaster flowers. The plants had been consistently seed sterile and were most likely hybrids. Their origin was unknown. Later we toured the Silverglen Medicinal Plant Project on the outskirts of the city. Although intended primarily to foster plant conservation among the native Zulu tribes, this project may someday become a source of unusual and hard to find plants for collectors. Hundreds of *Crinum* seeds and seedlings were under cultivation. There were also five potted *C. firmifolium* from Madagascar. These had a rapid growth history, as they were only two year old plants and already bore scapes with maturing seed pods. The pods had long apical projections and resembled *C. americanum*.

The Natal Botanic Gardens in Pietermaritzburg had very large naturalized plantings of *C. moorei*, and seedlings of *C. bulbispermum* were offered for sale in the accompanying nursery. The curator had collected three unknown *Crinum* species during recent field trips, which he hoped to eventually be able to identify.

The Botanic Gardens at Harrismith in North Natal and at Bloemfontein in the Orange Free State both harbored *C. bulbispermum* and *C. lugardiae*. No plants were in flower. During the ensuing drive, several blooming *Brunsvigia natalensis* were photographed on a grassy hillside (Figure 5).

In the Cape Province, the curator at the Albany Museum Herbarium directed me to several vleis known to contain *C. campanulatum* just to the north of Grahamstown. The location was called the "burnt kraal." It was a treeless grassland and housed three small

vleis which were completely dry. The ground was hard and cracked. Not a single shriveled *Crinum* leaf was seen. The curator related that in July or August after the winter rains begin, one can often find hundreds of flowering scapes at a given time. I drove to other listed sites in the area, but all vleis were equally dry. Near Bath I observed *Haemanthus* in bloom, but they were inside a fenced pasture surrounded by an unfriendly appearing bull and his harem of cows.

Crinum were also raised in pots of sand at the Kirstenbosch Botanic Gardens in Cape Town. *C. nerinoides*, a dwarf species, had finished blooming just prior to my arrival. There was a large colony of *C. campanulatum* in a permanent pond on the grounds, and several plants were in bloom. I was informed that the amaryllis worm was a pest even for *C. campanulatum*, as it would devour leaves down to the water level. While in Cape Town, I visited the nearby Rust-en-verde Nursery which had a nice assortment of *Crinum*. The owner was especially proud of his collection of *Cyrtanthus* hybrids.

In Verdoorn's article there were two locations listed in the Cape Province where *C. variabile* had been sighted (Figure 7), and I easily found them. Both were rocky stream beds which were bone dry. Each had full sun exposure. Only a few plants existed south of Nieuwoudtville. Although the leaves were brown and dried, several plants bore scapes in full bloom. The flowers had short tepal tubes, which was an important identifying criterion. Near Garies, there were hundreds of bulbs tightly wedged between the rocks in the stream bed. All the leaves were shriveled and brown. Several bulbs looked very large, perhaps 18-20cm in diameter, but a compressed air hammer would have been required to dislodge them from between the rocks.

South West Africa (Namibia) was the next leg of my travels. At the S. W. A. Herbarium in Windhoek, there was an excellent collection of mounted indigenous *Crinum* which I was permitted to examine and photograph. The curator provided me with many additional sites to supplement Verdoorn's article, including a copy of Roessler's article on South West African *Crinum* in German. (There are three official languages in South West Africa: English, Afrikaans and German.)

Although summertime was the usual rainy period in this arid land, it was the driest summer on record for 160 years. Many areas had not experienced rainfall in over a year. Only a narrow central corridor beginning at Windhoek and extending about 200km north had received recent rain, and this had mainly occurred within the previous three weeks. I traveled extensively throughout South West Africa, including the flood plains of the Okavango River on the Angolan border, but never once did I observe a single *Crinum* in the dry localities. On the converse, where there had been rain, it was a *Crinum* bonanza.

A quite obvious change in the landscape was appreciated as I approached Windhoek from the south. The terrain color turned from a hazy dull brown to dark brown with scattered greenery as I passed into the zone of recent rainfall. I was soon greeted by a disbursed colony of blooming *C. lugardiae* along the roadside. These were growing in sandy soil among clumps of long dried grass (Figure 9). Blooming scapes were exceedingly short, and narrow channeled leaf foliage was barely showing. Many scape tips and leaves were just emerging from the ground in unison. I later observed a much larger colony of blooming *C. lugardiae* east of Windhoek, situated in a broad but very shallow depression which appeared more like a water runoff than a streambed (Figure 8).

Undoubtedly the biggest thrill of my trip occurred about 90km north of Okahandja. It had recently rained heavily, and water was standing in the ditches along the highway. About 50m off the highway in a fenced pasture was a flooded vlei surrounded by hun-

Figure 10. *Crinum carolo-schmidtii*. Vlei 90km north of Okahandja, South West Africa. February 7, 1987.



Figure 9. *Crinum lugardiae*. Roadside 26km south of Windhoek, South West Africa. February 6, 1987.

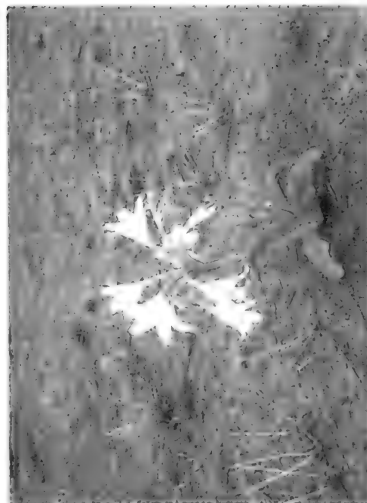


Figure 12. Probable natural hybrid between *C. carolo-schmidtii* and *C. macowanii*. Roadside 90km north of Okahandja, South West Africa. February 7, 1987.



Figure 11. *Crinum carolo-schmidtii*. February 7, 1987.

Figure 13. *Crinum buphanroides*. Roadside near intersection of Highway B-1 and D2404 north of Okahandja, South West Africa. February 7, 1987.



Figure 14. *Crinum delagoense*. Pasture 47km north of Okahandja, South West Africa. February 10, 1987.

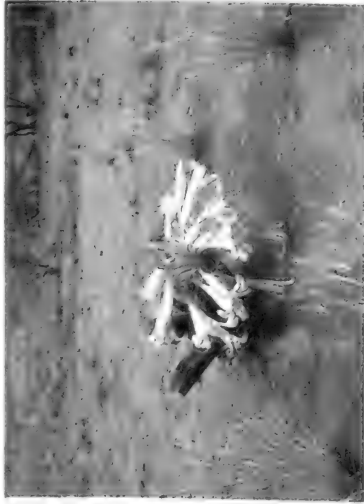


Figure 15. *Crinum delagoense* with seed pods. Near Paul Kruger Gate, Kruger National Park, Transvaal. January 27, 1987.



Figure 16. *Nerine laticoma*. Near stream 109km north of Otiwarongo, South West Africa. February 10, 1987.

dreds of *C. carolo-schmidtii*, many of which were in full bloom (Figures 10 & 11). All blooms were practically identical in age, and obviously the trigger (rain) which set off their blooming clocks had been applied simultaneously. Well-developed, glossy green, arching channeled leaves were present. Nearby to the north were two smaller vleis, and here all the scapes were showing buds, but not a single flower had opened. The buds displayed a very light pink stripe on the dorsal keel of the segments, but all flowers were completely white. Each umbel contained 3 to 5 flowers, and occasional small plants only had 1 or 2 flowered scapes. *Crinum* were not a protected genus in South West Africa, and as I was kneeling to dig several small bulbs for specimens, I was suddenly startled from behind by a loud animal sound. I was situated between four cows and their lunch. When I moved aside, they waded into the *Crinum* patch and began to hungrily devour them, especially the flowering scapes.

Many individual *C. carolo-schmidtii* were scattered about in the immediate area for about a kilometer or so around each vlei, including a few on the opposite side of the highway in the ditch. Next to a small group in bloom in the ditch was a larger *Crinum* which was also in bloom. However, it had a 10 flower scape, far too many for *C. carolo-schmidtii*. Its flowers had a light pink stripe along the keel with slightly recurved segment tips. Leaves were wider and somewhat undulating. I was very perturbed by this plant until I discovered *C. macowanii* in the ditch several hundred meters away. Then it was clear; the peculiar *Crinum* was a natural hybrid between *C. macowanii* and *C. carolo-schmidtii* (Figure 12). Its leaves resembled *C. macowanii* but were green rather than glaucous blue-green. The flowers were smaller than *C. macowanii*, more open-faced, and did not have the more exaggerated distal recurving of the segment tips. About a kilometer north of the main vlei was a crossroads and another surprise. Just off the shoulder of the highway was a closely packed group of six large *C. buphanoides*, several of which were in bloom (Figure 13). The light pink stenaster flowers were absolutely radiant. Less than 5m behind them was a blooming *C. macowanii*, and approximately 50m distant was *C. carolo-schmidtii* in bloom. Three species in simultaneous bloom at the same location! I did not observe any other natural hybrids though.

Continuing north along the same highway (Highway B-1) between Okahandja and Otjiwarongo, I found *C. macowanii* at multiple sites, usually adjacent to stream beds and drainage ditches traversing the highway. All plants had undulating, glaucous blue-green leaves which were never very long. Leaf margins were finely ciliated. Many plants were in bloom at most locations, with a few early seed forming scapes also present. Scapes were short and usually had 10 to 15 flowers per umbel. One plant had a 20 flower scape. Segments had dark pink keels, which were especially prominent in the fat horizontal budding stage prior to anthesis. The flowering cycle was very brief, because when I returned three days later, only a sporadic bloom was to be found at these same locations. Also occurring in the same region was *C. delogoense*. However, it preferred drier surroundings, usually sandy pasture land with a full sun exposure. It was usually observed as a solitary plant or a very loosely congregated group of less than six plants. All had short, broad channeled leaves with truncated ends. A few were in bloom (Figure 14). Scapes were extremely short in comparison to those observed in the Kruger Park. The umbels contained many flowers with conspicuous broad, bright pink keels on the segments. One scape had mature seed pods which were filled with seeds (Figure 15). The reason for the sparse population of this species became apparent when I returned three days later. All flowers in the pasture lands had been eaten by goats and cows, and the only ones which remained were safely positioned between the fences and the highway.

A common amaryllid found in and adjacent to streams was *Nerine laticoma* (Figure 16). In a shallow stream northeast of Windhoek, it was growing so thick that it resembled carpet. Every plant had an early scape at the same stage of maturity. I walked the damp stream bottom for several hundred meters, and the high concentration of plants extended for as far as I could see. In the drier wooded areas, I occasionally encountered *Boöphane disticha*, but it was never in flower. On the last day of my trip, I saw several tightly bunched clusters of *Pancratium tenuifolium* in bloom along the highway just north of Windhoek.

Summer rains commenced with a bang during the last four days of my journey. There was widespread flooding, especially in the south. Had I only been able to remain a few more weeks, I am certain I would have seen many more *Crinum*. A total of 15 species have been recorded in South West Africa according to Giess. Timing in conjunction with rainfall is crucial, and the opportunity to observe a particular species in bloom in the wild may not last longer than 2 or 3 days. Approximately 10 to 14 days is the usual interval from a heavy summer rain to the appearance of flowers. Near the Namib Desert of South West Africa, there are several huge shallow vleis which harbor *C. paludosum*. These plants have an interesting history of remaining dormant for 14 years between 1972 and 1986 because of the absence of summer rainfall. The curator of the S.W.A. Herbarium wrote to me that he visited the vleis two weeks after I departed and saw *C. paludosum* in bloom as far as the eye could see. I hope to return someday when it is raining.

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PLANT CONSERVATION IN NATAL

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ANCIENT human cultures discovered that certain plant extracts possessed healing or therapeutic properties. A variety of ethnic remedies and folklore medicines gradually evolved through the centuries. In primitive societies, superstition and witchcraft frequently were assimilated into the healing arts, probably because the scientific method was lacking and natural phenomena were poorly understood. The administration of magical chants and rituals became important and necessary components of the remedies. The fact that successful treatments sometimes occurred helped establish a strong political entity in the healer, whereas unsatisfactory results were easily attributed to the dark forces and evil spirits. Healers were held in awe even by ruling authorities.

The practice of herbal medicine referred to as *muti*, is prevalent among the Zulu natives of Natal. In addition to an assortment of dead animal parts, it is conservatively estimated that between 450 to 500 different plant species are utilized in *muti*. The so-called pharmacist or chemist who maintains a formulary and dispenses the ingredients is the *inyanga*, while the magician or witch doctor who prescribes the treatments and performs the rituals is called the *sangoma*. Neither individual has any knowledge or training in botany, biochemistry, or human physiology.

Many of the plants are highly poisonous. Apparently there are schemes which place restrictions on the amounts consumed or require cooking to inactivate some of the toxins. However, accidental deaths occasionally occur. It is widely recognized that *Scilla* plants are extremely toxic and sometimes lethal to livestock, yet portions of the bulb are eaten by the Zulu as a laxative. Several members of the Amaryllidaceae contain potent alkaloids, such as *Crinum* and *Haemanthus*. The Zulu drink extracts of *Haemanthus* bulbs to treat intestinal diseases. Readers desiring more detailed information on Zulu herbal medicine are referred to the text *Medicinal and Poisonous Plants of Southern and Eastern Africa* by Watt and Breyer-Brandwyk (currently listed at \$160).

The various bulbs, roots, leaves, flowers and barks possess a certain monetary worth to the consumer or patient. Bulbs may sell for as much as 1 to 3 Rand apiece. The bark of the rare stinkwood tree, whose wood is valued by furniture builders, trades for approximately 2 Rand per square inch.

The unfortunate aspect of Zulu herbal medicine is the enormous number of bulbous plants which are being dug from the ground. It is having a dramatic impact on the indigenous bulb ecology of Natal. The most prized bulbs, those of the genus *Scilla*, are being removed at an estimated rate of 500,000 annually. The second most sought after bulbs are *Eucomis* which are used as charms against witchcraft. Other popular genera include *Crinum*, *Clivia*, *Boöphone*, and *Brunsvigia*. It is likely that some species are rapidly nearing an endangered category. The outlook is especially dim, because the Zulu are experiencing a population explosion. My recent excursion over several hundred miles of remote dirt roads in Zululand resulted in a sighting of only four *Crinum* plants along the roadside. In an attempt to cope with this threat to the indigenous flora, a coalition of

Figure 1. Entrance to the Umlaas Nursery.



Figure 2. Cultivation of bulbous plants at the Umlaas Nursery.

conservation groups has undertaken a research program aimed at teaching the Zulu how to raise plants from seed. It is called the Silverglen Medicinal Plant Project. An experimental nursery, the Umlaas Nursery, has been established near the outskirts of Durban, where brood stocks of pertinent species are currently under cultivation. The curator, Geoff Nichols, reports that the district chiefs and administrative staffs of the KwaZulu have shown considerable interest in the plan. These officials are acutely aware that certain plants have become quite scarce, which is having significant economic impact on supply and demand to their peoples. It is hoped that commercial nurseries and farmers will also respond to the potential market for indigenous plants and begin to raise them to sell to the natives. Should this occur, amaryllid collectors worldwide could greatly benefit as new sources of hard to find and unusual species would be developed.

The program is still in its initial stages of development. Approximately 150 species of plants are currently under cultivation, including 6,000 *Scilla* bulbs, 4,500 *Eucomis* bulbs, and 300 *Crinum* bulbs. Donations of indigenous amaryllid plants are needed. Anyone having excess seeds may send them directly to the nursery. If bulbs are to be donated, please write to the Curator before shipping so that the necessary import permit can be obtained. The address is: Geoff Nichols, Curator Natural Areas, Parks, Recreation and Beaches Department, P. O. Box 3740, Durban 4000, Republic of South Africa.

THE HIPPEASTRUM SPECIES: SOME RECOLLECTIONS AND OBSERVATIONS BY AN AMATEUR GROWER

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IT WAS one of those bitterly cold, sunny winter days that can happen in the foothills of the Catskill Mountains of upstate New York. My father had harnessed the farm horses and we were bound to an Aunt's house for Thanksgiving. We were all bundled in blankets and scarves...our noses ruddy cold in the freezing air. But everyone seemed fairly comfortable in the hay-filled sleigh as we coursed over the frozen snowdrifts, and the unplowed roads, to Aunt Margaret's house.

Her combination farm kitchen and dining room were customarily closed off from the rest of the house to conserve heat. There was even a hand pump in the kitchen for well water. The room was heated from the iron wood-burning stove; the windows glazed over from the steaming kettles, cooking foods and water chamber in the stove. The large kitchen window looked out on the frozen snowbanks glistening from the winter sun. In front of the window sat an old, marred and chipped, marbleized tub filled with plants. From it were thrust at least a dozen orange lilies that were spectacular in their winter splendor...all leaning as far as possible toward the window. I surmised the pot was turned each day so the long scapes did not lean onto the frozen window. What a beautiful, graceful, even joyful orange mass these made. I was to learn many years later these were *Hippeastrum striatum*, originally from Brazil. That memory started a lifetime hobby that threatens to take over my valuable studio time teaching and working as a contemporary painter.

That winter experience was at the age of 12. That spring, I noticed at a neighbor's house two very large wooden tubs sitting on either side of the entrance stoop to a rather grand porch. They were full of lilies with a more trumpet-shape. The flowers were a spectacular display of deep red with stripes on each petal. It seems the neighbor stored them all winter in her vegetable cellar and brought them out each spring as they began to show buds. They flowered and grew all summer. I was to learn many years later that these were "*Amaryllis* × *johnsonii*"...the famed early hybrid of the English watchmaker.

For the potting soil both women seemed to have used well-drained farm loam with ample use of 3 or 4 years old cow manure from a compost heap, stacked and rotted at some distance from the farm buildings.

Some years ago my interest was sparked by the late grower, Wyndham Hayward of Orlando, Florida, and the famed plant explorer and collector, Mulford B. Foster, also of Florida. Two mature bulbs of *H. striatum* var *fulgidum* were purchased from Hayward. A bulb of *Hippeastrum reticulatum* 'Mrs. Garefield' came all the way from Bengal, India, in a tin box which I took immediately to the plant inspector in Chicago. He was fascinated that it had come this route even with tags for the USDA Plant Inspector then at Hoboken, New Jersey. It gave up its lovely, finely fretted lavender flowers in the fall from its almost artificial looking leaves—vividly striped and ornamental. Hayward introduced me to Dr. Traub, who would send a few recently arrived seeds or an occasional bulblet of some newly discovered species, in trade for a drawing. He could be a shrewd bargainer. Foster had sent *H. blumenavium* (syn. *Griffinia blumenavia*), bare rooted and

in flower through the mail. For days, I searched through Curtis' Botanical Magazine in the dark attic library of the Field Museum in Chicago, trying to learn its growing requirements. Foster had generously, but simply, sent the rather cryptic message: "grow them."

About this time I made the acquaintance of Kitty Clint...a lovely, warm friendship developed with this gracious woman, as it was to later with her daughter, Marcia Wilson.

My small Amaryllis collection had to be dispersed...mainly to the Amaryllis specialist at the Garefield Conservatory in Chicago. I was appointed to be sent to London as the first American Exchange Professor to the Royal College of Art.

After moving East, to get my work promoted in a supposedly more sympathetic and encouraging "market" area, I became interested again in *Hippeastrum*. My wife saw *H. striatum* in a little tailor's window up the street; I knew I was again bitten by the *Hippeastrum* bug. I wrote to Len Doran in California for his price list and purchased a few to add to *H. striatum*...mainly 'Manchae,' indeed a beauty and probably a much larger relative of *H. striatum*. In correspondence, he introduced me to Marcia Wilson. Over the years a friendly, warm correspondence developed between Wilson and Craft...many off-sets were in fact sent to Marcia who almost always exclaimed how well grown and packed for shipment they were. She had a way! As Doran suggested, Marcia was to write a book on the *Hippeastrum* species and Craft was to do the drawings. My collection grew and grew...my wife even threatened! The beautiful variety of *H. evansiae* (probably Korsakoff's selection) came by purchase from Park Seed Company, along with *H. calyptratrum*. *Hippeastrum evansiae* grew to three pots—gorgeous! Beautiful, graceful blooms each spring until this past year when I was devastated by the ugly narcissus fly grub. Len Doran had helped me save most of the collection by the "heat treatment," but many mature bulbs from the general collection were lost and the rest are only now beginning to recover.

I would always have "*H. striatum*"; nostalgic and such a vigorous, easy and ornamental grower. It has been known to bloom three times a year with its lovely, graceful flowers. It is another species I would always have.

H. calyptratrum is a Victorian fan lady, ornamental when just in leaf. Add to that its green color, banana lacquer-like fragrance, and its strange incurved flower. It is almost an epiphyte itself, growing in a partial orchid mix. For me, it is a heavy feeder all summer...blooming either at Thanksgiving, Christmas, or New Year's.

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(Please advise the Editor of
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